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Centre canadien de la technologie des minéraux et de l'énergie

Efficiency and Alternative Energy Technology Branch

Direction de la technologie de l'efficacité énergétique et des énergies de remplacement

Energy, Mines and Resources Canada
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THE ENERGY OF OUR RESOURCES · THE POWER OF OUR IDEAS

L'ENERGIE DE NOS RESSOURCES · NOTRE FORCE CREATRICE

SYSTEM-SPEC
POWER SYSTEM DESIGN SOFTWARE
USER'S MANUAL

PREPARED FOR:

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SYSTEM-SPEC™ Power System Design Software - - User's Manual

0.0 TITLE PAGE

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2.0 ABOUT SYSTEM-SPEC^{tm}...

System-Spec is the world's first commercial computer software product created expressly for the integrated purpose of design, characterization, comparison and quotation of PV (solar electric) and engine generator based alternative energy power supply systems. System-Spec was created in 1987 to provide a fast, easy-to-use, but highly powerful system design and analysis tool that could benefit a wide array of users - from the inexperienced to the seasoned professional. The program was co-written by one of the world's top hybrid power system design specialists miles from the nearest public utility power line, using energy produced by one of the very same systems it now designs.

2.1 What System-Spec Does

Helps you to realistically design, model, and cost, average systems without investing a small fortune of your most precious resource - TIME.

Among other things, (such as performing wire sizing calculations and world currency exchanges) System-Spec allows the user to document, design, quote, tabulate, compare and file four main types of alternative electrical energy supply systems. These are:

- "Gendirect^{tm}": Engine generator stand alone systems
- "Gencharger^{tm}": Engine generator battery charging systems
- "Photogenset^{tm}": Combination PV (solar electric)/engine generator battery charging systems
- "Solectric^{tm}": PV (solar electric) battery charging systems

Owing to its flexible format, System-Spec can be creatively employed to help model other types of hybrid battery charging systems as well, including hydro, wind and utility supported designs. (All it takes is a little designer imagination...)

But please *don't take our word for it!* Test drive the program and see for yourself if it's what you need!

2.2 What System-Spec Doesn't Do

Waste your time!

System-Spec does not employ an internal weather data base for reference [*see item #2.3(B) below for why!*].

System-Spec does not attempt to reinvent the PV array design wheel by calculating/modeling minute by minute PV device IV operating characteristics, NOCT, or plane of array insolation and associated weather data.

System-Spec does not *directly* calculate esoteric (and readily arguable!) factors such as "loss of load probability," "lowest life cycle cost," or "line tie system economics" (of any type).

System-Spec does not size loads, model water pump output, calculate battery state of charge vs. time, specify manufacturer part numbers when reporting hardware requirements, or *directly* perform "system type vs. application" design optimization or "relative component tradeoff" routines.

Other programs which perform one or more of the above functions are already available in one form or another (#2.3 below names a few).

2.3 Why System-Spec?

At the time of its original commercial release, several other software products with similar sounding capabilities were available. (These include PV F-Chart$^{(R)}$, PV CAD^{tm}, PV Form, SIZEPV and WATSUN-PV, not to mention numerous other proprietary programs written by prime equipment manufacturers for controlled internal use.) Several of the referenced programs can actually be gotten for "free" (i.e., without paying an up front purchase price in hard dollars). System-Spec differentiates itself from these fine programs in the following critically important areas:

A) It was created from the ground up to *realistically* size the system types noted above in the manner which they are actually required, conceived, purchased and used in the real world. *System-Spec works like people do.* It is not an "ivory tower" program.

B) System-Spec was designed with the premise of "*GARBAGE IN = GARBAGE OUT*" foremost in mind. In other words, given that the two most primary pieces of system design input data are truly subject to relatively poor accuracy (site weather characteristics and system load energy requirements), why waste the user's time with a complex and pretentious arsenal of time consuming data input requirements and correspondingly obtuse output information? System-Spec places "ease of use" and "speed of execution" well ahead of the pursuit of (unattainable) .0001% "simulation accuracy."

Note: For the "doubtfully inclined" who put serious stock in commonly used modes of PV array output simulation, i.e., those which rely on solar resource data garnered from original studies which have been generated using "real data" obtained from the few world meteorological sites generating it on a consistent basis and therefore scoff at the "Garbage In" statement above, we encourage you to carefully read the fine print in the aforereferenced original studies!

C) To accommodate the skeptic in us all, System-Spec readily *accepts the net output of any third party program* as an input for completion of a system design. Because of this, System-Spec can work in tandem with the PV output simulation program of your choice.

D) System-Spec was written for use by *anyone*. It is readily understandable and does not require an engineering or computer science background nor expensive hardware to utilize efficiently. Fully menu driven and interactive, there are *absolutely no cryptic commands to learn or syntax to follow*. You're the master, it's the slave. As a result, designers can truly concentrate on designing in real time for a change!

E) System-Spec was written to address *most of the basic requirements of the serious system design professional* including system quoting in any world currency desired, before your customer dies "on hold." Elegant secretarial file management and other friendly operating utilities are provided. It supports individual "Stylesheet Designing™" with flexible spreadsheet design trait comparison. The output report format permits inclusion of designer narrative text and eliminates the need for post processing work and/or separate cost quotation. Best of all, all calculations and reporting, including iterative design looping for system optimization, occurs in seconds on even the slowest of computers!

System-Spec *manufactures time*, it's the closest thing you'll find to a "human copy machine" for your design department.

2.4 System-Spec Comes in A Variety of "Flavors"

There are three main types of program copy available:

- Demo
- Leased
- Licensed

The types are primarily differentiated only by the terms of useage you must agree to before use, the subject materials provided, and field update eligibility. The basic differentiations are noted below, but first a sober word about (ulp!) copyright protection is in order.

A) Copyright Protection is Serious Business and We're Very Serious About It!

Please carefully read the "System-Spec™ Software Use, License & Warranty Provisions" provided herein.

Please do not attempt unauthorized use (abuse) of the software. Besides being unfair, it is quite illegal; lawyers have plenty to eat as it is without unauthorized users cooking more for them.

For those who like to cook just the same, it may be interesting to note that there's a great big attack shark among the sea of copyright protector champions called the Canadian Federal Government (yep, "Mounties" and all). You see, the Canadian Government itself owns a significant piece of the System-Spec™ pie and has every intention of keeping it that way by sending the modern equivalent of "Dudley Do-Right" to all would be pirates' doorsteps if so requested/necessary. (Sigh... the lengths a society has to go to protect its interests at times.)

There are always a few bad apples out there completely willing to spoil things for the rest of us in pursuit of their own self interest. In recognition of this sad fact, we have undertaken some rather unique and quite elaborate copy protection mechanisms. Far more than meets the eye, or even the creative imagination. You may encounter one or more of these obstacles, and should employ this as a consistent response in order to avoid undesirable unpleasantries:

- Read the message displayed carefully
- Follow the message's instructions carefully

If the above is thoughtfully adhered to, you will remain very safely on the correct side of the copyright law fence.

Thank you for your careful consideration and thoughtful compliance.

B) Demo Copies

Demos are provided for very temporary use (for a "look-see" before buying), are not provided with full manuals, any form of technical support services, nor supported with field updates.

- To operate a demo, type "SS" and press "Enter," then follow the screen menu.*

C) Leased Copies

Leased copies are provided for specified temporary use, are provided with full, current manuals, have technical support services available, but are not supported with field updates.

- To operate a leased copy, press "S" and "Enter," then follow the screen menu.*

D) Licensed Copies

Licensed copies are permanent use copies, are provided with full current manuals, have technical support services available, and are field supported through provision of five years' worth of free software version updates.

- To operate a licensed copy, press "S" and "Enter," then follow the screen menu.*

E) AHEM! It Doesn't Work!

*Note: If the "S" (or "SS" for the demo) command doesn't work, it's because your computer already has a "batch file" installed which precludes use of that provided with System-Spec. As a result you'll have to type "CD \System-Spec" (omit the quote marks and ensure there's a space between the "D" and the "\" as shown here), *then* press the "S" (or for demos type "SS").

2.5 Hardware Requirements

System-Spec is written for IBM compatible personal computers, and supplied in your choice of 3 1/2 or 5 1/4 inch floppy disk format for installation to, and subsequent use from, a hard disk drive. System-Spec can be operated from a floppy drive, but *without the ability to print or save its files.*

System-Spec cannot be transferred using "LAPLINK," "FILESHUTTLE" or similar software programs, and you cannot make "normal backup" copies of the software (for copyright protection reasons).

To use with Apple computers, an emulation (translation) program such as "PC Soft" (or equivalent) is required.

System-Spec can be used on computers with 360K or larger floppy disk drives, which have a minimum of 450K uncommitted RAM available. A math coprocessor is not required, but if present, is utilized. Mice are not supported.

Monitor support is provided for black and white, laptop, monochrome, and color monitors.

Printer support is provided for various common dot matrix, daisy wheel and laser printers.

2.6 Software Specification Trivia

System-Spec is written in Turbo Pascal. It contains +528K of executable code compressed to +310K so that (older) 360K drive based computers can run the program.

Version 2.0 has +25,000 lines of source code, comprised of +1,250,000 characters, and to date has taken an investment of over 4,000 man hours to create. As of 4/1/90 total program development cost has soared well beyond $200K 1990 U.S. dollars. Better than half that sum has been expended on making the program both fast and easy to use.

Enjoy!

2.7 Feedback Please!!!

Your constructive comments, criticisms (ulp!), praise, scolding, loves, hates, etc. feedback is *most encouraged.* This software was created to *serve YOU...* of course we had to *guess* at how to do that! Users can help take the guesswork out of the picture by letting us know how we fared. Please provide feedback in writing so our supervisor won't think we're making it up!

RÉSUMÉ

System-Spec est le premier logiciel commercial au monde qui ait été mis au point expressément pour les travaux informatiques touchant les piles solaires (piles photovoltaïques) et systèmes d'énergie à groupe électrogène. Ce logiciel sert à la conception, à la détermination des caractéristiques, à la comparaison et à l'estimation du coût. System-Spec a été créé en 1987 afin d'offrir à une grande variété d'usagers - qu'ils soient sans expérience ou rompus à ce genre de travail - un logiciel rapide, convivial mais très puissant pouvant servir à la conception et l'analyse à de systèmes d'énergie. Le logiciel a été rédigé par l'un des grands spécialistes mondiaux de la conception des systèmes d'énergie hybrides, qui a travaillé a des milles du réseau d'électricité le plus proche, en faisant appel à une source d'énergie produite par l'un des systèmes que System-Spec permet maintenant de développer.

2.1 Fonctions de System-Spec

System-Spec permet à l'utilisateur de concevoir quatre principaux types de systèmes d'énergie :

"Gendirect^{MD}" :	groupe électrogène autonome
"Gencharger^{MD}" :	groupe electrogène couplé à des accumulateurs
"Photogenset^{MD}" :	modules photovoltaïques et groupe électrogène couplés à des accumulateurs
"Solectric^{MD}" :	modules photovoltaïques et accumulateurs

Par la souplesse de son format, System-Spec se prête à des applications créatrices débouchant sur la modélisation de systèmes chargeurs hybrides, y compris les systèmes partiellement alimentés à l'énergie hydro-électrique ou éolienne ou par les réseaux d'électricité. (Il suffit d'un peu d'imagination ...)

2.2 Pourquoi System-Spec?

Au moment où System-Spec a été mis sur le marché, il existait plusieurs autres logiciels du même genre. (Il y avait PV F-Chart$^{(R)}$, PV Form, SIZEPV et WATSUN-PV, sans oublier de nombreux autres programmes brevetés rédigés par les principaux fabricants de matériel, pour usage interne contrôlé.) System-Spec diffère de ces autres logiciels sous plusieurs angles importants.

a) Tout d'abord, ce logiciel a été conçu à partir de l'étape de planification pour déterminer avec **réalisme** la taille des systèmes mentionnés ci-haut en fonction de la manière dont ils sont effectivement conçus, vendus et utilisés. System-Spec fonctionne dans le réel.

b) System-Spec a été créé avant tout en fonction du principe GIGO (garbage in - garbage out) : on tire d'un logiciel ce qu'on y met. Autrement dit, vu que les deux principaux éléments d'information qui entrent dans la conception des systèmes sont d'une exactitude comparativement peu élevée (conditions météorologiques du site et demande d'énergie), pourquoi faire perdre son temps à l'usager en mettant entre ses mains un arsenal d'exigences d'entrée de données consommatrices de temps ayant comme résultat des données de sortie non pertinentes? System-Spec privilégie la facilité d'utilisation et la vitesse d'exécution plutôt que la recherche illusoire d'une précision de simulation à .0001 % près.

c) Pour contrer le scepticisme dont nous sommes tous coupables, System-Spec **accepte les sorties de n'importe quel autre logiciel** comme entrée aux fins de la conception des systèmes. Il fonctionne également en jumelage avec le logiciel de votre choix.

d) System-Spec vise **n'importe quel utilisateur**. Il est facile à comprendre et il n'est pas nécessaire d'avoir un diplôme en informatique ou en génie, ni un matériel coûteux, pour l'exploiter avec efficacité. C'est un logiciel entièrement interactif et piloté par menu **sans aucune commande cryptique à apprendre ni syntaxe à respecter**. System-Spec permet enfin réellement au concepteur de ne faire que son travil de conception.

e) System-Spec est également conçu pour satisfaire à **TOUS les besoins fondamentaux du professionnel de la conception technique**. Il comporte d'excellents fichiers conviviaux, notamment un système de gestion des dossiers d'une grande simplicité. Il supporte le logiciel individuel "Stylesheet Designing^{MD}", qui offre la comparaison souple des caractéristiques techniques par tableau électronique. Le format des rapports des données permet d'inclure un texte narratif et élimine la nécessité de procéder à un post-traitement ou encore d'inclure des estimations de coût séparées. Mieux, les boucles d'itération d'optimisation des systèmes se traitent en quelques secondes, même sur l'ordinateur le plus lent.

Le manuel d'utilisation System-Spec suppose que l'utilisateur :

- connaît quelque peu les principes de base de la conception et de l'exploitation des systèmes électrogènes
- déteste **passionnément** les manuels de programmation
- connaît passablement l'ordinateur qu'il utilise
- préfère apprendre en travaillant, plutôt que par les livres

Le manuel d'utilisation est bref, et c'est voulu. On encourage l'usager à lire le point 6.0, de passer au logiciel et d'en faire le tour, puis de revenir au manuel. (Comme référence, on peut aussi faire appel, en tapant F1, à la fonction aide sur l'écran.)

3.1 Soutien technique

Photron assure un service d'aide auprès des personnes ayant versé les droits d'utilisation, pendant les heures d'affaires normales, du lundi au vendredi. Téléphonez au bureau le plus proche.

Canada : (403) 675-2586 (Alberta)
É.-U. : (709) 459-3211 (Californie)

Demandez le soutien technique System-Spec et ayez votre numéro de licence du logiciel à portée de la main.

3.0 SYSTEM SPEC'S MANUAL

3.1 Manual Use Is Truly Optional!

System Spec really doesn't need a manual per se. As noted under item #2.6, significant effort was expended during creation to make the software as intuitive in operation as possible. Generally speaking, when in doubt or confused "do the *obvious* thing," i.e., avoid the human tendency to make wildly esoteric assumptions. Instead, *carefully* read on screen program messages/instructions; take them *verbatim* and as *having priority* over both your personal assumptions AND this manual(!). *You'll be surprised at how easy this makes the software's use overall.*

This manual is in its infancy and hence incomplete. It is intended to be a fluid (growing) document, that's why licensed copies are provided in a three-ring binder! All sections—most notably(!) those delineated as "TBP" (To Be Provided) in the Table of Contents—are subject to unscheduled revision (or creation in the case of "TBP's"!) in the not too terribly distant future as the program and its user base evolves—and time permits!

Meanwhile, System-Spec's manual does assume that its prospective users:

- are somewhat familiar with the basic concept of power system design and operation
- hate software manuals with a passion(!)
- are remotely familiar with the computer they are using
- prefer to learn by doing, not by "reading about doing"
- are more intelligent than the average avocado

The manual is intentionally brief. Users are encouraged to read item #6.0, jump right into the program and browse around, then come back here if desired. *Please note that several "Sample" files have been preloaded into the program's File Register (see item #4.2) for your initial browsing convenience; please review them.*

System-Spec's on-screen context sensitive help notes (accessed via the "F1" command) can be employed to very simply learn program use, thereby instantly relegating this manual to kitty box liner status.

This manual is not intended as a "system design primer." However, you will find that among other aspects of the program, through the use of the "Mailbox" utility, System-Spec can be used as a rather effective teaching aid for the uninitiated beginner.

3.2 Technical Support

As with many commercial software packages, such as Wordstar(R), Autocad(R), etc., System-Spec™ is sold without a technical support package included. Technical support (i.e., "how to design," "general design know how," and misc. "tricks o' the trade," etc.) is provided separately for those who desire it, on an as needed basis only. This helps keep costs down for everyone involved, especially those who require no assistance at all, and don't appreciate being charged for yours!

Support assistance to prepaid accounts is available from Photron during normal 9 A.M. - 5 P.M., Mon. - Fri. local business hours by calling the Photron office nearest you:

Canada: (403) 675-2586 (Alberta - Mountain Standard Time)
USA: (707) 459-3211 (California - Pacific Standard Time)

Request "System-Spec Technical Support" and be sure to have your software copy license number ready for verification. Technical support is provided at the hourly rate of $50 U.S./$60 Can., with a .25 hr. minimum per call charge. Support time must be prepaid, or billable to an accepted credit card (Visa/Mastercard).

- END OF 3.0 -

4.0 GENERAL PROGRAM OVERVIEW

System-Spec^{tm} is divided into 8 sections as follows:

SECTION	TITLE	DESCRIPTION
A	Contents	Title page and table of contents for program
B	File Register	Directory of Design and Spreadsheet files stored to date by the user
C	Worksheet	Design data input form filled out by user to create Design Files
D	Report	Design output provided and stored in response to a given Worksheet input
E	Spreadsheet	Tabulation utility for the direct comparison of user selected Report parameters from user selected Design Files
F	Design Appendix	Lookup and edit table for misc. design values the program uses in computing both its worksheet design window and help/error message contents, as well as its output Report data - attached as an integral part of all Design Files
G	Quote Appendix	Lookup and edit table for use in creating the cost quotation portion of the output Report - attached as an integral part of all Design Files
H	Currency Index	Lookup and edit table for use in establishing the currency units utilized in all areas of the program where costs are displayed.

System-Spec is written like a book. The above Sections are like "chapters" in a book. Once inside a Section, the individual screen displays are like "pages" within a book's chapter. The extreme bottom of each page contains function key commands for program utilities that are responsive to the context of that particular page. Users may freely jump from Section to Section, browse from page to page, and read up or down a given page, just as one would in a book. The following details each Section's contents and purpose:

4.1 Section A: "Contents"

This is the first portion of the program you see upon entry, commonly referred to in software as "the main menu." It consists of a single page which lists the program Version #, System Types designed, program Section # titles, the 9 screen pages of the Worksheet Section, and the 6 topical areas covered by the Report for reference.

The Contents page is the unique platform from which users may:

- Read "Help Notes" that detail how to move around and function within the program - press "F1"
- Install diskette copies onto the computer's hard disk (or transfer same onto an alternate size floppy disk) - press "F3"
- Set up the screen display for the type of monitor in use (4 to choose from) - press "F7"
- Zip ("autoload") directly to the precise point they were at when exiting the program during the previous use session - press "F4"

4.2 Section B: "File Register"

This is System-Spec's tireless file secretary. It is a multipage section which sequentially lists all stored Design and

Spreadsheet files created to date by computer drive on which they're located. As such, the File Register is System-Spec's "catalog" from which you can review or sort stored files for general reference or selected file by file reading. Whenever (and wherever) a file is saved, the File Register is automatically updated accordingly.

It is important to note that System-Spec maintains its File Register content entirely separate from the program itself. For example, when licensed users install a new program version, only the operating program itself is installed. *Existing File Register Contents are not affected in any way.* Likewise, files can be moved in and out of your program copy (to other authorized System-Spec users for example, or simply to backup diskettes) without affecting the operating program itself in any way.

The File Register is the platform from which users may:

- Read, import, export and destroy Design and/or Spreadsheet files as desired
- Select Design files for entry into the Spreadsheet utility
- Execute Stylesheet Designing™
- Review current computer drive #, File Register file content quantity, and available computer disk space

4.3 Section C: "Worksheet"

This is System-Spec's "front end."

The Worksheet is the multipage data input "form" (and menu) used to create a power system "Design File" from which the file's output design "Report" is computed.

The Worksheet is comprised of nine topical screen "pages" as follows:

WORKSHEET SCREEN PAGE #:	SCREEN PAGE TITLE:	SCREEN PAGE DESCRIPTION:
1	Clerical Data	Entry form and menu for system type to be designed, and misc. design information including designer "scratch pad" notes. Also provides a mailbox "mail received" visual notification location ("mail" program consists of various program messages deposited to alert users of possible design errors and/or information missing for Design Report completion).
2	Load and Transfer	Entry form for system load requirements, and AC power transfer switching Switch Bank Datadetails (where relevant)
3	Genset Bank Data	Entry form and menu for system's available engine generator specifications and maintenance details (where relevant)
4	Power Inverter Bank Data	Entry form and menu for system's available DC to AC power inverter specifications (where relevant)
5	Genset-powered Charger Bank Data	Entry form and menu for system's means of battery charger characterization (where relevant)
6	PV Array Data	Entry form and menu for system's solar source means of energy contribution, general operating specifications and physical format (where relevant)

WORKSHEET SCREEN PAGE #:	SCREEN PAGE TITLE:	SCREEN PAGE DESCRIPTION:
7	Battery Storage Bank Data	Entry form and menu for system's means of battery bank characterization and general operating specifications (where relevant)
8	Quotation Data	Entry form and menu for governing content of output Design Report's "System Quotation" subsection
9	System Wiring Data	Entry form and menu for system design circuit characterization and minimum wire size requirements, as well as misc. "on-the-fly" wire sizing calculations

Note that once a given system type is selected for design, System-Spec omits Worksheet data entry parameters which are not relevant to that particular system type's design process. (Example: When sizing a Solectric™ PV Stand Alone system, all genset input parameters are automatically eliminated from display on the Worksheet..., etc.)

One unique aspect of System-Spec is that it instantly updates its current output design Report as each Worksheet line is filled in (or subsequently revised). Users may vary any Worksheet design parameters, and *view the variation's effect on the resultant design as fast as they can hit a single key!* This incredible speed is the key to System-Spec's powerful user-interactive design optimization capability.

When output as hard (paper) copy, the Worksheet totals five printed pages (two screen displays fit onto a single printed page). The print copy is crisply formatted and designed to serve as a standalone document.

4.4 Section D: "Report"

This is System-Spec's Design File output document. The Report is a multipage compilation of system specifications and operating characteristics computed directly from input parameters provided on the Worksheet as computed with the technical, cost and currency values established in the System-Spec Appendices and Index.

The Report is comprised of six topical sub-sections spread over ten screen "pages" as follows:

REPORT SCREEN PAGE #:	SUB-SECTION # & TITLE:	SUB-SECTION DESCRIPTION:
1	1.0 Clerical Data	Repeats basic worksheet clerical information about the design to permit expedient orientation
1-5	2.0 System Quotation	Lists prime system component specifications, operating characteristics and mech./elec. format, unit quantity and cost. Summarizes misc. component and service costs, as well as total system price, price tolerance, delivery time and validity period
6	3.0 Report Notes	Provides a designer "scratch pad" for inclusion of misc. information the user wishes to have accompanying the Report for the benefit of the reader
7,8	4.0 System Operating Characteristics	Tabulates all output data which characterizes system operation and field performance
9	5.0 System Economics	Lists system & prime component life and operating costs, replacement quantities and associated costs, plus total system life cycle and energy production costs
10	6.0 Administration	Provides statements clarifying Report utility, responsibility, and program copyright notice

When output as hard (paper) copy, the Report totals five printed pages. The print copy is in a crisp, business-like format that easily stands alone. The document is designed and intended to serve as not only a detailed design report, but as a complete system quotation/proposal instrument as well. This feature saves designer time as it eliminates the need for additional post processing.

4.5 Section E: "Spreadsheet"

This is System-Spec's design run "result comparison" tabulation utility. Once in Section E, pressing the "Control" and "F1" keys simultaneously will provide on-screen program notes for how to create Spreadsheets.

The Spreadsheet is a multipage Section that allows users to tabulate program output Report parameters of their choosing from the Design Files they select out of the File Register. System-Spec Spreadsheets are ideal for use where you want to *personally organize and precisely focus* reader attention on a *limited number of design parameters* as opposed to the much larger barrage of information contained within the standard Report section. In essence, the Spreadsheet lets you report things more "your way."

Spreadsheets are created, identified, filed and read independent of the program's Design Files, yet stored within the same File Register for easy access. Should a given Spreadsheet's user selected Design Files be revised after creation of the Spreadsheet, its tabulated values are automatically updated for you via a single keystroke.

In addition to the simple tabular comparison of misc. Design File Report results, the System-Spec Spreadsheet allows designers to easily compare the net system operating changes arising out of both Worksheet input parameter and Appendix constants value changes. This feature enables designers to readily explore the sensitivity of a given system specification or operating characteristic to a particular input design variable. Spreadsheeting of designs greatly facilitates and efficientizes the overall "user based fuzzy logic" design optimization process.

The entire Spreadsheet Section is contained within 4 screen pages that provide a total of 3 separate tables (fields), each comprised of 7 vertical columns (for Report parameter insertion) by 13 horizontal rows (for Design File selection). This permits comparison of up to 21 common Report parameters (i.e., 3 tables x 7 columns each) from up to 13 different Design Files. Each table includes a "User Comments" column for insertion of special row-by-row narrative remarks and a "Footnote" column for insertion of row-by-row footnotes. Footnote text can be entered as desired at the bottom of the Spreadsheet (page 4), where a total of 20 text lines for handy consolidation of all table Footnotes (by their respective reference numbers) are provided for this purpose.

The Spreadsheet provides 3 prime header lines which the user may fill with text as desired to personalize the underlying tabulation. When output as hard (paper) copy, the Spreadsheet totals 2 printed pages. The print copy is formatted and designed to serve as a stand-alone document.

4.6 Section F: "Design Appendix"

The Design Appendix is a multipage "lookup and edit table" utility that permits the designer to review and alter the design constants used by the program's algorithms. These constants affect not only the output Report data computation, but the essential triggering and value content for various Worksheet "pop-up" design window and error message text as well.

The Design Appendix utility is an important aspect of System-Spec designing for the more experienced user. It allows precision tailoring of the program to readily accommodate everything from unique engineering requirements to simple designer prejudice. It is also an extremely important tool for the support of the System-Spec Stylesheet Design™ approach as we'll see later on... (in item #7.0 herein).

The Design Appendix lists its alterable constants alphabetically by their respective acronym. Each acronym is defined in the table listing and accompanied by its current (user definable) value and units of measurement. The program allows designers to freely alter each acronym's values as desired, *providing plenty of rope with which to hang oneself* (and the resultant system design). System-Spec supports the concept of "freedom of choice" to the Nth degree! (Its author feels that nothing is more @$!X:>?% frustrating than having your individual creativity dominated by myopic software engineers.)

The program is very democratic. System-Spec neither requires that the Design Appendix be used (it's "hidden" way in back...) nor that a given design be stuck with the use of any particular appendix value set. With a single keystroke, designers may select from any of the following three options for appendix value definition:

A) "Standard System-Spec values"

The program permanently maintains its author's originally ascribed values for your use. (These are recommended for general use and especially for beginners.)

B) "User-defined Default values"

For those of you "who beg to differ with the author," you are welcome to create your own individualized value set, line by line, precisely as desired. This value set is then *stored integrally as part of the program* [i.e., not solely as part of a given design file, as in (C) below], alongside those of (A) above.

C) "Values from Current design file"

These are comprised of those values currently employed by the Design File name shown on the screen. [Note that these may be created "on the fly" - for the design as you design - *but never stored separately* (as an integral part of the program) as in (B) above. Rather, "Current values" *are stored only as a part of a given design file itself.*]

The particular Design Appendix value set utilized in computation of a given design (i.e., one of A-C above), is automatically stored with that design as it is filed (saved). When output as hard (paper) copy, the Design Appendix totals exactly 1/2 the number of screen pages displayed (rounded up to nearest whole number). The print copy is crisply formatted and designed to serve as a standalone document.

4.7 Section G: "Quote Appendix"

The Quote Appendix is conceptually identical to the Design Appendix, with the notable exception that its particular value set is used solely in the preparation of the design Report's "System Quotation" and "System Economics" subsections. It is provided as a separate appendix for two reasons:

- Ease of Setup...

System-Spec generally does not attempt to suggest what your current equipment and labor costs are, nor what business margins ought to be. As a result, users must "set up" such values when desiring this area of program use. The separate appendix format facilitates this process by minimizing the mandatory "search and set" bureaucracy.

- Cyclical Revision and "Stylesheeting™" Requirements...

Costs and margin requirements can vary daily, and are a definite "personality factor" in the Stylesheet Design™ process. Once again this mandates minimization of "search and set" bureaucracy.

As with the Design Appendix, the Quote Appendix permits users to select from a menu of three Quote Appendix value set options [see items (A), (B) and (C) in #4.6 above]. The value set thus selected is used as a basis for all program cost calculations. The only difference is that the "System-Spec values" option is devoid of actual values, i.e., it yields all "*****" ("asterisks") as the value set so that users may instantly establish totally original value sets from scratch.

4.8 Section H: "Currency Index"

The Currency Index is a multipage "lookup and edit table" utility that permits the user to easily display System-Spec's cost quotations in any currency unit desired. These currencies can be "real" (today's Swiss Francs, etc.) or "fabricated" (1999's inflated U.S. dollars), because the index permits user creation and insertion of currency units and their corresponding exchange rates (versus all other currencies) precisely as desired.

System-Spec is shipped with international exchange rate values for actual world currencies loaded into the Currency Index. It is important to note, however, that because exchange rates shift on a daily basis, users must:

A) initially revise the Index before attempting execution of bona fide currency exchanges for the first time, and...

B) ensure that the Index is loaded with current exchange rates on any given future day that a bona fide currency exchange is to be executed.

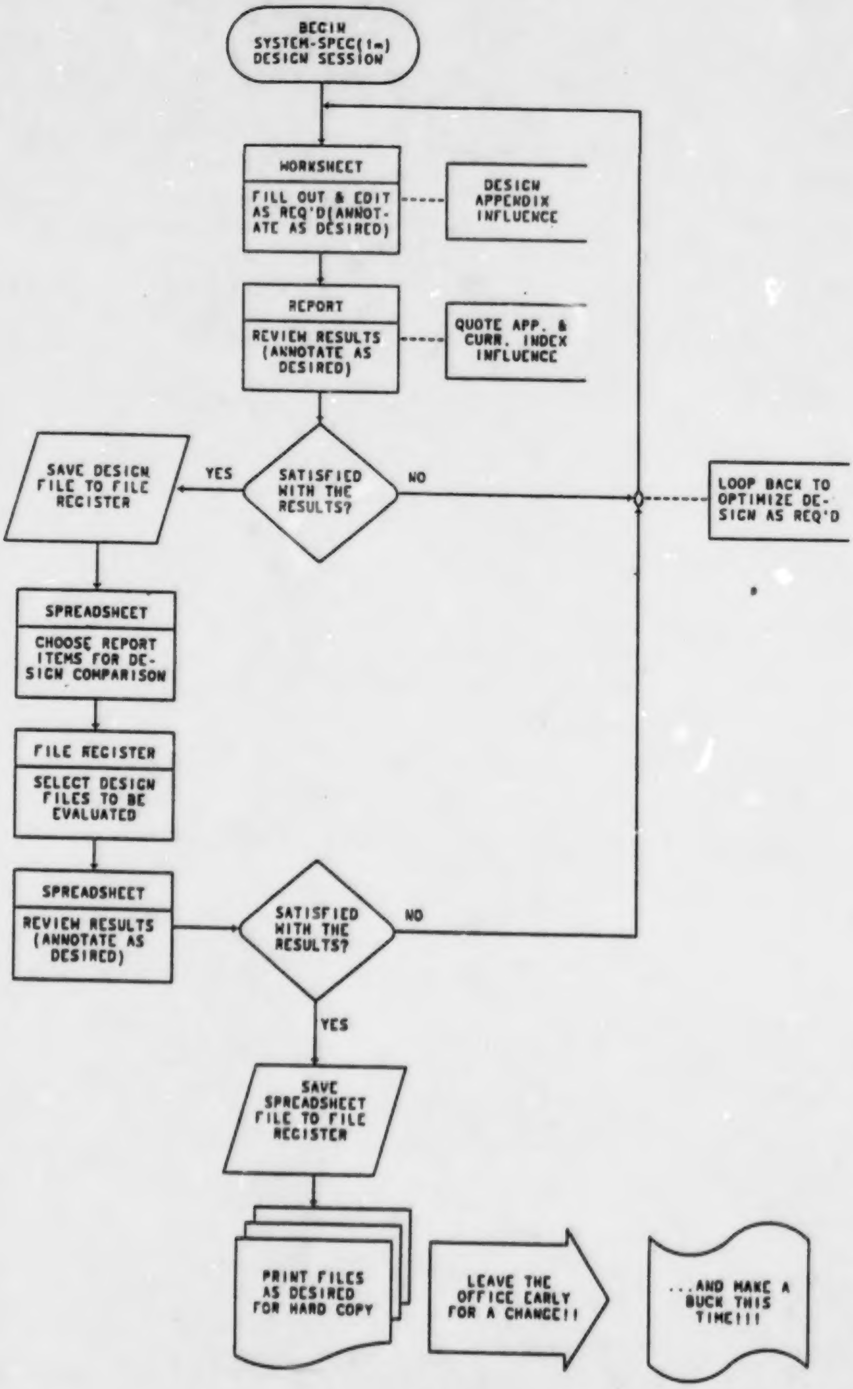
Current exchange rates can be obtained from many sources including large daily newspapers. Be careful when requesting rates from banking institutions, as often times these will have currency exchange service fees factored in which distort the actual exchange rate.

The Currency Index can be employed in many ways. An obvious use would be to routinely convert system design quotations/economics from one national currency to another (e.g., system quotes done in Mexican Peso's can be instantly changed to Venezuelan Bolivars with a single keystroke). Less obvious uses are the creative valuations of designs at different *inflation rates*, or even global (across the board) *profit margins*. A little creative thinking will unearth all sorts of useful applications.

Regardless of Currency Index application, System-Spec stores all cost values in consistent units of the user's own specified index defined "Domestic Currency." Design files stored with a different System-Spec Domestic Currency are automatically converted (exchanged to) and displayed in a given user's own Domestic Currency as the design file is read, without a single keystroke being required.

When output as hard (paper) copy, the Currency Index totals exactly 1/2 the number of screen pages displayed (rounded up to the nearest whole number). The print copy is crisply formatted and designed to serve as a standalone document.

FIG. 4.9: CONCEPTUAL OVERVIEW OF THE BASIC SYSTEM-SPEC™ DESIGN SESSION PROCESS...


BEGIN SYSTEM-SPEC(tm) DESIGN SESSION
WORKSHEET
FILL OUT & EDIT AS REQ'D(ANNOTATE AS DESIRED)
DESIGN APPENDIX INFLUENCE
REPORT
REVIEW RESULTS (ANNOTATE AS DESIRED)
QUOTE APP. & CURR. INDEX INFLUENCE
SATISFIED WITH THE RESULTS?
YES
NO
SAVE DESIGN FILE TO FILE REGISTER
LOOP BACK TO OPTIMIZE DESIGN AS REQ'D
SPREADSHEET
CHOOSE REPORT ITEMS FOR DESIGN COMPARISON
FILE REGISTER
SELECT DESIGN FILES TO BE EVALUATED
SPREADSHEET
REVIEW RESULTS (ANNOTATE AS DESIRED)
SATISFIED WITH THE RESULTS?
NO
YES
SAVE SPREADSHEET FILE TO FILE REGISTER
PRINT FILES AS DESIRED FOR HARD COPY
LEAVE THE OFFICE EARLY FOR A CHANGE!!
...AND MAKE A BUCK THIS TIME!!!

- END OF 4.0 -

5.0 THE FOUR SYSTEM TYPES

System-Spec was created to assist in the design and characterization of the four diverse system types noted earlier (in item #2.1). Upon entry to a blank design Worksheet, the user must specify the type of system to be sized in order to properly proceed into the design process. Note that System-Spec is a "context sensitive" program. This means that only those design parameters relevant to a given system type are made available for consideration. (Tip: "Photogenset systems utilize the greatest number of program parameters; for initial browsing, select it to permit the most detailed of program inspection.)

As noted in item #3.0, detailed discussions pertaining to individual system types are beyond the scope of this manual. What follows is a simple block diagram and operating summary provided for general orientation purposes for each of System-Spec's four system design types:

5.1 The "GENDIRECT^{tm}" System...

The "old standby," inefficiently in use for generations!:

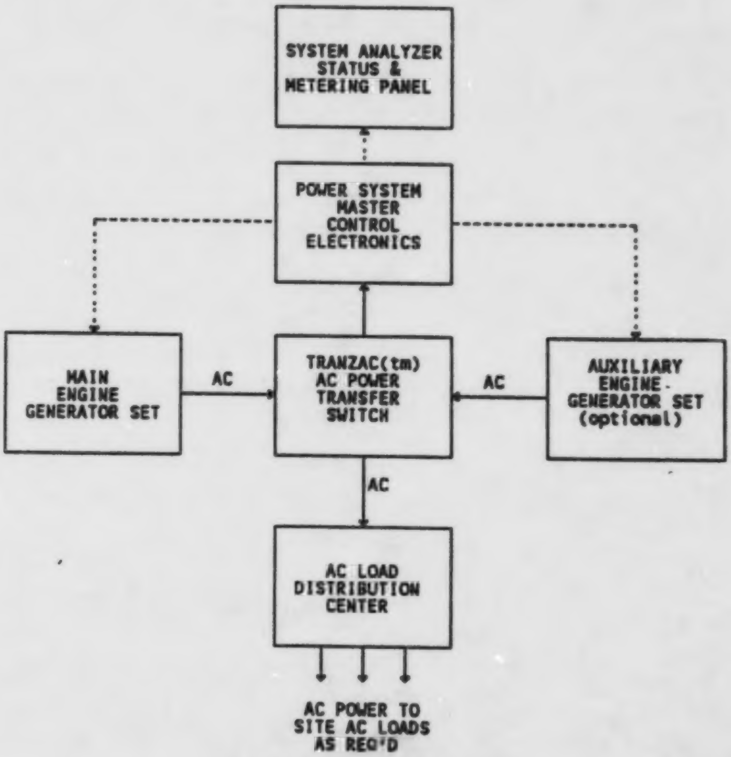

SYSTEM ANALYZER STATUS & METERING PANEL
POWER SYSTEM MASTER CONTROL ELECTRONICS
MAIN ENGINE GENERATOR SET
AC
TRANZAC(tm) AC POWER TRANSFER SWITCH
AC
AUXILIARY ENGINE-GENERATOR SET (optional)
AC
AC LOAD DISTRIBUTION CENTER
AC POWER TO SITE AC LOADS AS REQ'D

FIG 1: THE GENDIRECTtm SYSTEM

KEY: NET POWER FLOW = ________

CONTROL SIGNALS = ---------

A) Logic of operation...

Because no energy storage medium is present (save the on-site fuel tank!) whenever any power is required, a genset must be run continuously. Multiple gensets are typically installed for fail-safe redundancy. The overly simple looking layout masks the true relative reliability level and life cycle cost benefit of this system type. These are generally both quite poor due to the equipment's relatively high duty cycle and typical light engine loading (relative to installed capacity).

5.2 Alternative Systems: Energy Storage is the Key

The key to promoting cost efficient and reliable system operation is to operate the energy source at or near its maximum power production capability as is feasible. The basic concept is: "Use it or lose it"! With fossil fuel fired gensets, this means running them at their full (installed) capacity rating. For PV (solar generators) this means drawing current from them at or near their effective maximum power point for the entire duration of time that sunlight is falling upon them. If an "ideal load" of sufficient capacity and "operating personality" (i.e., one "careful" not to overload the source) is available, direct operation from the energy source is most always the best means of system operation. However, such an "ideal load" is rarely present in systems. Enter energy storage mechanisms....

With the ability to properly store energy, the system enjoys the advantage of more often having a nearly "ideal load" as described above. (This is especially true if the load is predominantly DC.) In System-Spec, the energy storage medium is most often a secondary (rechargable) electrochemical battery - typically the common lead acid "deep cycle" variety. A primary goal of efficient System-Spec designing is to utilize the storage battery to help create and maintain an "ideal load" for as much of the system's field operation time as is feasible.

The other three system configurations recognized by System-Spec incorporate battery energy storage. Each is a variation on a common theme, differing only in respect to the energy source utilized to produce the given system's required load power.

The following block diagram summarizes the remaining System-Spec system types (these are collectively referred to as "POWERUPS™ systems," as each is capable of providing an uninterruptible source of power supply):

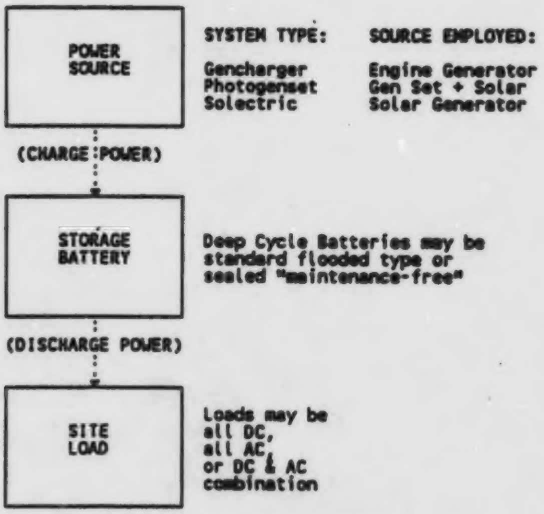


FIG 2: THE POWERUPStm SYSTEM

A) Logic of operation...

Energy produced by the Power Source, beyond the effective utilization capacity of the Site Load, is stored in the Battery for subsequent consumption as required.

With this as a premise, we'll now briefly explore each of the 3 Powerups' system configurations.

5.3 The "GENCHARGER^{tm}" System...

Rumored to have been developed long ago by the prolific inventor Thomas Edison, the Gencharger configuration is enjoying a tremendous resurgence in popularity today. This is due to its feature of relatively low cost for high energy production capability (as compared to the balance of the Powerups system family). It is the first step up from the Gendirect system type:

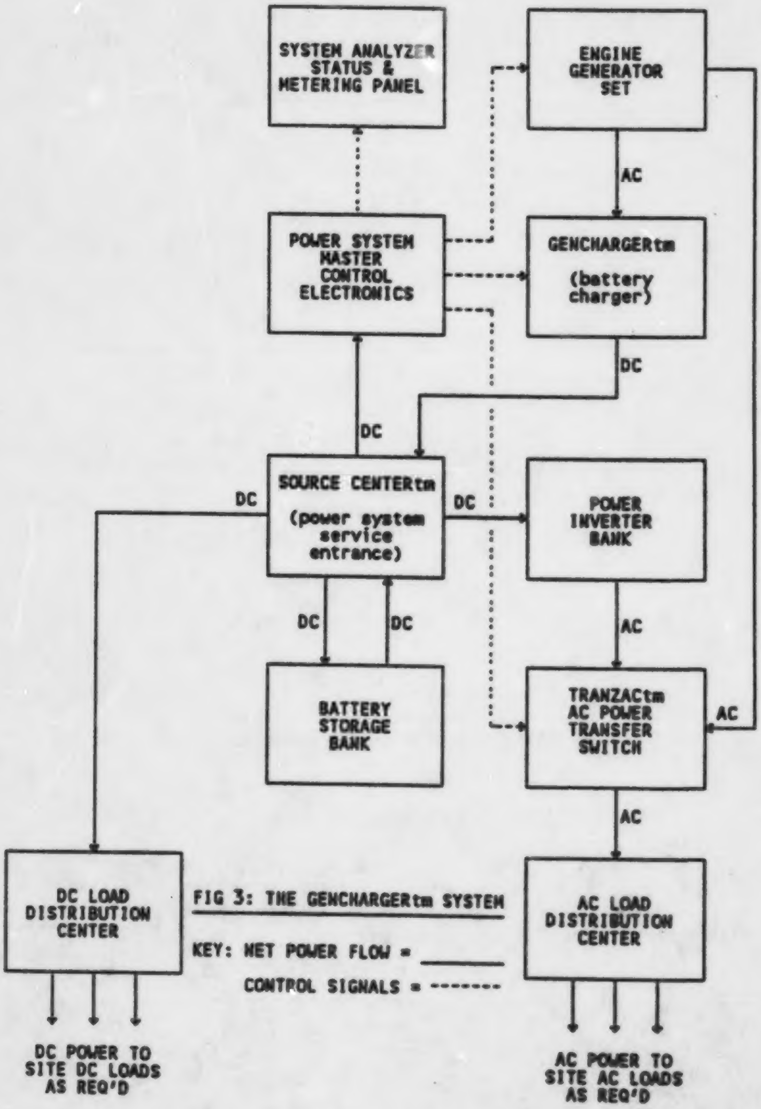

SYSTEM ANALYZER STATUS & METERING PANEL
ENGINE GENERATOR SET
AC
POWER SYSTEM MASTER CONTROL ELECTRONICS
GENCHARGERtm (battery charger)
DC
DC
SOURCE CENTERtm (power system service entrance)
DC
DC
POWER INVERTER BANK
DC
DC
AC
BATTERY STORAGE BANK
TRANZACtm AC POWER TRANSFER SWITCH
AC
AC
DC LOAD DISTRIBUTION CENTER
AC LOAD DISTRIBUTION CENTER
DC POWER TO SITE DC LOADS AS REQ'D
AC POWER TO SITE AC LOADS AS REQ'D

FIG 3: THE GENCHARGERtm SYSTEM

KEY: NET POWER FLOW = ______

CONTROL SIGNALS = -------

A) **Logic of Operation...**

The Engine Generator ("genset") is operated cyclically, primarily to replenish the Battery Storage Bank, while also direct powering any concurrent loads (when permitted by design). At all other times the genset remains off.

5.4 The "PHOTOGENSET™" System

Commercially developed and trademarked by Laurence Jennings (this software's co-author) as a means of obtaining "the best of both worlds," this system type combines the strengths of genset and PV energy sources (on-demand power and high reliability, respectively), while minimizing their respective weaknesses (operational reliability and high system cost, respectively). It is a logical extension of the Gencharger system type:

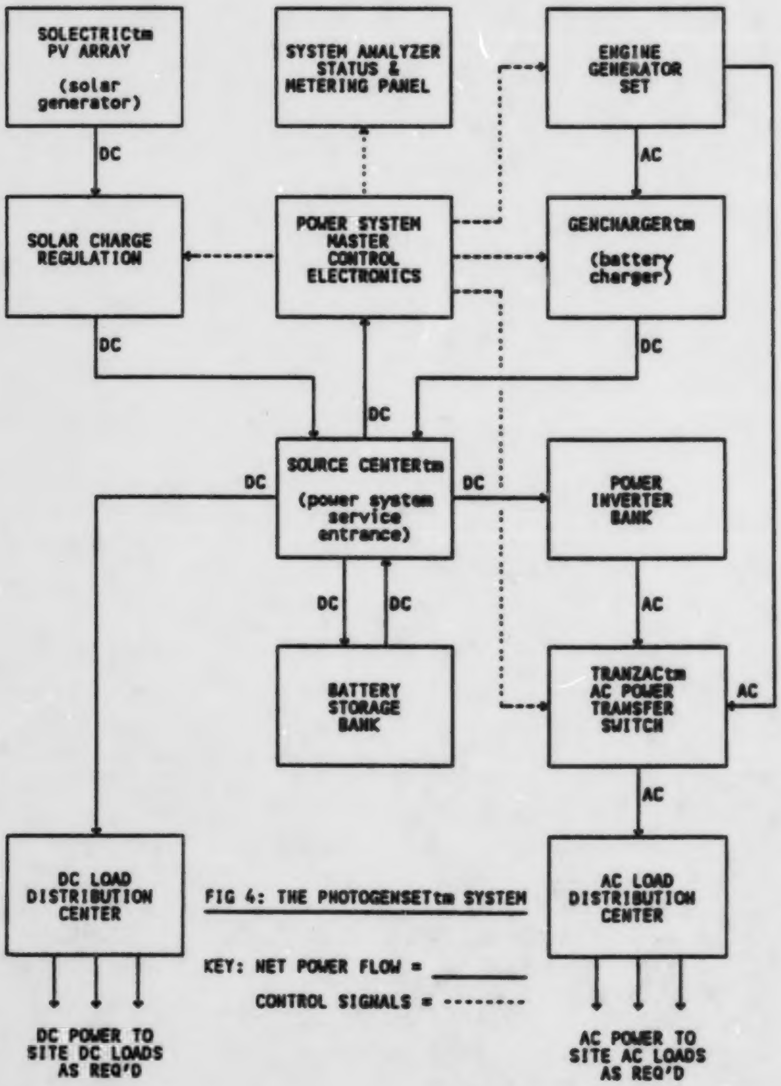

SOLECTRICtm PV ARRAY (solar generator)
SYSTEM ANALYZER STATUS & METERING PANEL
ENGINE GENERATOR SET
DC
AC
SOLAR CHARGE REGULATION
POWER SYSTEM MASTER CONTROL ELECTRONICS
GENCHARGERtm (battery charger)
DC
DC
DC
SOURCE CENTERtm (power system service entrance)
DC
DC
POWER INVERTER BANK
DC
DC
AC
BATTERY STORAGE BANK
TRANZACtm AC POWER TRANSFER SWITCH
AC
AC
DC LOAD DISTRIBUTION CENTER
AC LOAD DISTRIBUTION CENTER
KEY: NET POWER FLOW = ________
CONTROL SIGNALS = --------
DC POWER TO SITE DC LOADS AS REQ'D
AC POWER TO SITE AC LOADS AS REQ'D

FIG 4: THE PHOTOGENSETtm SYSTEM

A) **Logic of operation...**

Operation is essentially the same as that of the Gencharger. However, as a result of the dual energy source format the genset can immediately (or eventually) assume the role of "backup" power producer - dependent upon the level of PV contribution that's designed in. (Note: System-Spec excels at concisely aiding the designer in making this often difficult "how much PV contribution to include" decision.)

5.5 The "SOLECTRIC™" System...

First popularized by Bell Labs in the 1950's, and subsequently developed by aerospace interests, Solectric (solar-electric) systems utilize extremely high reliability PV (solar powered generators) to produce 100% of the system load energy consumed. Beyond this "solar is the sole source" difference, the balance of system operation is more or less identical:

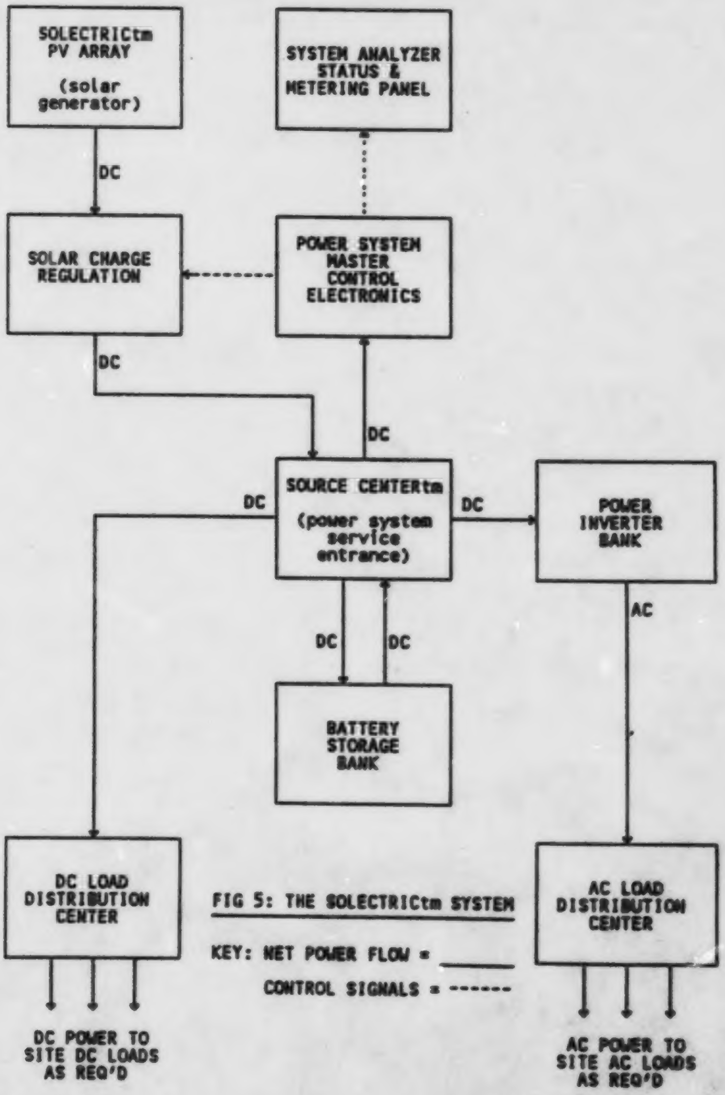

SOLECTRICtm PV ARRAY (solar generator)
SYSTEM ANALYZER STATUS & METERING PANEL
DC
SOLAR CHARGE REGULATION
POWER SYSTEM MASTER CONTROL ELECTRONICS
DC
DC
SOURCE CENTERtm (power system service entrance)
DC
DC
POWER INVERTER BANK
AC
DC
DC
BATTERY STORAGE BANK
DC LOAD DISTRIBUTION CENTER
AC LOAD DISTRIBUTION CENTER
DC POWER TO SITE DC LOADS AS REQ'D
AC POWER TO SITE AC LOADS AS REQ'D

FIG 5: THE SOLECTRICtm SYSTEM

KEY: NET POWER FLOW = ______

CONTROL SIGNALS = ------

A) **Logic of operation...**

The PV array silently contributes required energy to the storage battery and any concurrent load whenever sufficient sunlight falls upon it. Should the load require power in excess of what the array is currently producing, the balance is drawn from storage. Should demand also exceed the existing storage capacity, load operation ceases. (Therein lies a substantial disadvantage of this system type, especially for more complex load profiles.)

5.6 System-Spec as an Aid to System Type Selection

As can be seen from the foregoing, selection of the best system type for a given application is not necessarily a clear cut decision. This is especially true when vendor claims as to product/system performance are tossed in (apples to oranges) to further muddy the decision makers field of view. System-Spec assists the decision making process, in that it provides a level and consistent playing field for direct "apples and apples" life cycle performance assessment of ALL system types. Decision makers can thus be provided with a RELATIVE picture of system benefit, and thereby exercise their own better judgement in system selection.

- END OF 5.0 -

6.0 BASIC USE OF THE PROGRAM

As stated earlier in item #3.0, System-Spec can be used without recapturing this manual from the "cat box liner function" most manuals often seem to be written to serve. The following material is provided as a summary for those respectable, blessed souls who practice the lost art of reading instructions before using the product in order to efficiently obtain maximum benefit of use with minimal pitfalls of frustration. The rest of you can comfortably jump right in to the program (see #6.1 below) and just utilize the on-screen "F1 Help Notes" to get suitably acquainted.

Please note that several "Sample" files have been preloaded into the program's File Register (see item #6.7 to access these) for your initial "jump in and browse about" convenience... please review these.

!!!GENERAL READING AND PROGRAM USE RULES!!!

A) All discrete keyboard commands are shown inside these brackets: { }, *in the exact sequence of their input.* When using, type only the *CONTENTS* of the brackets; i.e., omit the brackets themselves.

B) When a given *singular* key command is required, the instructions will say "press" rather than "type." Example: "Press {Enter}," means... depress the key labeled "Enter," etc.

C) Inputs may be your choice of all upper, lower, or mixed case (i.e., System-Spec doesn't care).

D) You must *first* press {Enter} on any given program line to "open up" the line's editing window for inserting (or changing) information. To store the information thus inserted, press {Enter} *again.* (This will "close" the window, and advance the cursor to the next program line.

E) The program is menu driven and interactive. Menu choices are made by pressing the desired choice's I.D. letter (if present), or the first letter of the choice itself (where proper I.D. letters are omitted for some perfectly ridiculous reason).

F) When a pop-up window issues an instruction, *"Select"* means to "pick one of several choices shown," whereas *"Enter"* means to "type in something" (or accept whatever is already shown).

G) *"Load"* means "call up" (i.e., retrieve from File Register).

!!!CAUTION: POTENTIAL CONFUSION & EASTER EGGS AHEAD!!!

Like any piece of well designed software, software engineers take great pride in throwing in 97 ways of doing any given task in their attempt to be "user friendly" (read "fiendly" - actually it's done for job security during the manual writing process, after which they contract to provide 163 years of field support in helping users understand the manual). Anyway, System-Spec is no different, except that I have the kindness in my heart not to force you to read the 96 additional ways herein *just to find ONE that works.* So if you discover neato tricks here and there, congratulations are certainly in order (and I'll bet you're probably good at Easter egg hunts too). Just don't become confused, insult the manual, or demand royalty payments for your various discoveries by phone - OK? Enjoy...

6.1 Setup

Carefully read the "System-Spec Software Use, License & Warranty Provisions" and item #2.4(A) provided herein.

A) Turn on computer.

B) Place Program diskette into inactive floppy drive.

C) Log onto above floppy drive
(i.e., type {?} then {:} then {Enter}, where the "?" is replaced with the above drive's #, e.g., {A} for the A drive, etc.).

D) Press {S} and then {Enter}, if your copy is a leased or licensed copy. (Type {SS} and press {Enter} if you are using a System-Spec demo disk.)*

You're in! (You may wish to press {F1} to learn how to "move around" at this time; otherwise see #6.3 below.)

Remember that System-Spec is not able to store or print files when used from a floppy drive.

*Note: If the "S" (or "SS" for the demo) command doesn't work, it's because your computer already has a "batch file" installed which precludes use of that provided with System-Spec. As a result you'll have to type "CD \Sys-Spec" (omit the quote marks and ensure there's a space between the "D" and the "\" as shown here), *then* press the "S" (or for demos type "SS").

6.2 Installing Program to Hard Disk (or an alternate floppy)

A) Execute #6.1 (A-D) above.

B) Press {F3}
(then respond to each of the screen prompts as desired).

C) Once the install procedure is permitted to execute itself, program hieroglyphics will flash by, and ultimately you'll get a "Success" message... then press {Esc}.

You're done!

6.3 Moving Around, Acting Purposeful, and Exiting

A) System-Spec is set up like a book. Its "Sections" are like "book chapters," while individual screen displays are like "book pages." As with a book, you may freely turn its pages (screens) or chapters (sections) as desired.

B) "Sections" are changed in sequence with the "-" and "+" keys, where: "-" = "go back" and "+" = "go forward."

C) "Sections" may also be selected directly by pressing their respective ID letters (A, B, C..., etc.).

D) Screen displays (i.e., software "pages") are changed in sequence with the "<" and ">" keys, where: "<" = "go back" and ">" = "go forward."

(Note: Unlike a book, when you come to the final page of a Section pressing {>} loops you right back to that Section's first page. It will not place you in the next Section - steps (B) and (C) above do that.)

E) Screen displays may also be selected directly by pressing their respective subsection numbers.

F) Cursor movement is made with the arrow keys on the numeric keypad.

G) You must *first* press {Enter} on any given program line to "open up" the line's editing window for inserting (or changing) information. To store the information thus inserted, press {Enter} *again*. (This will "close" the window, and advance the cursor to the next program line.

Numerical values entered (or subsequently calculated and displayed) which are physically larger than a given line's digit containing capacity are automatically displayed with an "SI" unit system suffix denoting the numerical units employed ("K" for thousands, "M" for millions, "G" for billions, etc.).

H) The bottom of each screen lists special key functions effective for that screen. Additionally, you may press {Shift}, {Alt}, and {Ctrl} keys as desired to review additional information and access keystroke commands that can perform a variety of fancy functions.

For example, pressing {Shift} and {F1} simultaneously will show the nifty numeric keypad functions for the particular screen displayed.

Pressing {Alt} and {D} simultaneously will permit a quick escape to DOS, etc. Explore away...

I) Pressing {Esc} gets you cleanly out of any trouble.

(Note: If you're in "lots of trouble," you may have to press {Esc} a few times, i.e., just keep pressing until you're clear of whatever disaster you've worked yourself into!)

J) Press {F9} to save and file your current work, no matter where you are in the program.

(Tip: Save your work regularly to avoid computer headaches; we've made it easy to do for that reason.)

K) To exit System-Spec, press {Alt} and {Q} simultaneously, and respond to the prompts.

6.4 Cursor Position Memory

A) As you leap around the program (and from previously stored file to file), System-Spec will deposit the screen cursor wherever it was (on a particular screen display) when you last departed that screen (or that file). So for true high speed fun and frolic, just keep your eye on the cursor; System-Spec does all the driving!

B) Upon program re-entry, the {F4} "Autoload" command in Section A zips you to precisely wherever you exited the program at the end of your previous session. (System-Spec's memory is guaranteed to be better than yours!)

6.5 Creating Design Files

A) Design Files are automatically created when you save a Worksheet.

B) Original Worksheets are created by pressing {C} (to get to the Worksheet Section), then pressing {F8} (to call up a blank Worksheet).

C) Before System-Spec will allow you to create (fill in) a new Worksheet accessed with the "F8" command, it prompts you for your selection of the Design and Quote Appendix values you wish to employ for the program's various computations. (See item #4.6 and 4.7 for details as to this "Appendix" hocus-pocus.)

If you're clever enough to escape the above prompt, you'll get "Standard System-Spec values" by default. [No one escapes this!]

D) Filling out (or changing) the Worksheet (or any other program section user enterable data for that matter) is accomplished by positioning the screen cursor over the desired line, [via the arrow keys, see item #6.3 (F) above for details] and pressing {Enter} in order to "open the line" for your data entry.

When finished, pressing {Enter} again will store the data you've entered, instantly cause all dependent program values to be recomputed accordingly (where relevant), and advance the screen cursor to *the next program line which permits data entry.*

Proceed in this manner until the Worksheet (etc.) is completed as desired. There is no need to complete the Worksheet (or any other program section) in order to save it via the {F9} command (see item #6.6 below).

You may save ANY work you do at ANY time you like (in fact, regular saving of your on-screen work is strongly encouraged!) In this regard, System-Spec is like a simple notebook or file cabinet; you can toss in and save whatever you like. (Retrieving your stored goodies is explained in item #6.7 below.)

6.6 Saving ANY Design or Spreadsheet File

A) Press {F9}
(except to individually save a particular User Default Appendix file; this requires you to press {F4} while inside the respective Appendix).

B) Remember that the "saving" action is a "data replacement" (overwriting) action. In other words, *what you save replaces (destroys) what you started out with.* If there is a need to save the material you started out with for any reason, see item #6.9 (B) below.

Whatever you saved is now safely stored (and listed) in the File Register (program Section B) by System-Spec's tireless filing secretary.

The secretary stores files in sequential order (vertically in columns - top to bottom, then horizontally in columns - left to right), first in response to the "Design File Name" (as entered by you on Worksheet line #1.01), and then sequentially listing common Design File Names by their respective "Design Revision #" (as entered by you on Worksheet line #1.03). Dashes (-) are given first sequential listing priority), Numerals are second (in ascending numerical order), Letters are third (in ascending alphabetical order), and underscores (_) are last.

Design Files are computer assigned a "D" suffix, Spreadsheet Files an "S" suffix. (This is so they're easy to tell apart if you use a common file naming system.)

Note that Appendix files are not individually listed within the File Register, as are Design and Spreadsheet Files. See items #4.6, 4.7 and 7.0 for further details. (Tip: Item 7.0 will unlock the secret to manually storing and listing "Current" Appendix files in the File Register, to your heart's content!)

6.7 Calling Up ANY Stored File

A) Press {B}
(to get to the File Register).

B) Place the screen cursor onto the file name you want.

C) Press {Enter}.

Per the Easter Egg Hunt Caution above, there are all sorts of fancier ways to call up files (in context even!), but if you're smart enough to learn them, you're smart enough to find them by pressing {Shift} and {F1} simultaneously. (Have fun, and hold on to your hat!)

6.8 Creating Spreadsheet Files

You do have to be extra smart for this, to acquire the "smarts":

A) Press {E}
(to get to Spreadsheet Section).

B) Press {Ctrl} and {F1} simultaneously for instructions
...then start reading (i.e., instructions are provided right on screen where *we hope* your dog can't chew them up).

The Spreadsheet utility is quite powerful and there are lots of nifty tricks you can teach it (it can teach you). But the fun gets lost in translation, so just call it up and fiddle around 'til bedtime.

(Tip: Press {Shift} and {F1} simultaneously to land up to your ankles in Spreadsheet commands.)
[See also: item #6.11(B)]

6.9 Revising ANY Existing File

Files stored in the File Register can be easily revised as often as desired, in any manner desired. Simply use procedure #6.7 above to open the file to be revised, and revise away!

Use procedure #6.6 above to save your revision work...

A) **IMPORTANT:** If you want the revised file to REPLACE the original file opened, you need only save your work via the {F9} command. (The original is then destroyed by the revised copy's insertion into its place in the File Register.)

B) **IMPORTANT:** If you want the revised file to NOT REPLACE the original file opened, simply assign it a "Revision #" on line #1.03 of its worksheet. (The original is then left in tact, and co-exists with the revised file upon saving via the {F9} command.)

It is the ease and freedom of System-Spec file revision that is the key to the program's powerful Stylesheet Designing™ capability (refer to item #7.0 herein for further details).

6.10 Selecting Units of Measure

In program Sections C-G, System-Spec gives you a choice of displaying, storing and printing its values in any one of four different unit groups as follows:

A)	"Metric" Units:	As the name implies (long live the metric system!)
B)	"American" Units:	As the name implies, from a country yet to appreciate the wonders of the Metric system.
C)	"SI" Units:	The respected "Systeme International" (International system) of standard units employed by the scientific community to great advantage.
D)	"Imperial" Units:	Out of due respect for the language this manual was originally written in.

When used for the very first time, the program "wakes up" with whatever unit system is most commonly employed in the diskette's origin country. In Sections C-G, you may press {F2} (as often as required) to toggle the units to those you desire to employ. Thereafter, the program will always wake up employing the unit system in use when last exited.

(Tip: When in doubt, employ "Metric" units; they're more widely appreciated!)

6.11 The Mailbox and its Mailman

When designers make boo-boo's (as far as the program is concerned) System-Spec calls them "Errors" in true dumb computer fashion. In an attempt to be helpful, naughty designers are notified of such "Errors" as they are attempted. Being the "freedom of choice" program that it is, System-Spec will generally (not always!), allow you to override its wisdom and make whatever bizarre design decisions (data entries) you see fit as long as they don't result in program crashing. (It tries to draw the line there!)

However, once so overridden, System-Spec does two things:

A) It notifies the mailman. He places a "mailbox" symbol onto the Worksheet's first page as a gentle reminder of the design-rule-check battle it fought (and lost). Press {F6} to read the "mail" inside ("letter" by scalding "letter"!). With a given "letter" in hand, press {F3} to be whisked directly to the offending data entry, in case you'd like to reconsider (correct) your heinous design crime. If you wish to continue designing without addressing the particular design crime indicated, simply press {F6} again to continue onward through your trek. Should you ultimately repent all crimes, the "mailbox" eventually disappears.

B) A ">" symbol is tagged on as a prefix to Design File names when said mailbox containing files are inserted into Spreadsheets. This is a flag to indicate that you are performing "post processing" (value added) work on potentially rotten designs!

The {F6} and {F3} commands come in real handy if you want to examine a given Worksheet (and/or attendant Quote Appendix) for misc. minimum information you may have to provide in order to obtain a 100% complete Report. Using these commands, as prompted by the screen messages they invoke, will lead you on a "search and set" mission throughout the Worksheet (and/or Quote Appendix) in an effort to assist/expedite the proper entry of all essential program information. Upon completion, a "Sorry, no mail today" message is issued accordingly - just to let you know that all required information is neatly tucked into place as required.

(Tip: For those terminally curious about the precise order in which the program goes about executing its various design computation tasks, exactly where design value interdependencies exist, and other such esoteric considerations - the {F6} and {F3} commands will take you on a wild ride through the basic process. Just sit back and key yourself into oblivion!)

6.12 Working with the Design Appendix, Quote Appendix and Currency Index

Please review this manual's items #4.6, 4.7 and 4.8 to become familiar with respective Appendix and Index program functions before attempting to work with them. It is important to remember that System-Spec DOES NOT check the information you insert into Appendix or Index tables for accuracy; it accepts all data as given, and computes accordingly!

The instant a table value is changed, ALL program computations affected by it are instantly changed as well. This feature allows designers to quickly become familiar with a particular design's sensitivity to a given table reference value.

A) Press {F} to directly enter the Design Appendix.

B) Press {G} to directly enter the Quote Appendix.

C) Press {H} to directly enter the Currency Index

Once inside the desired Section, use the on-screen menu (at base of screen display) to assist your work. Table values are individually alterable in the same manner as are Worksheet line items [refer to item #6.5 (D) above].

It is helpful to remember that should you at any time wish to reinstate a particular Design or Quote Appendix value set, the on-screen {F8} command can be used to do so in a flash!

To reinstate original (default) Currency Index values from those altered "on the fly," press {Shift} and {F3} simultaneously. *Do not touch the {F4} key*, as this *destroys (overwrites) the existing currency default file* which the program woke up with when your current use session began.

Attempted entries of ridiculous values which might cause the program to crash (i.e., become unable to compute) will be instantly rejected by System-Spec.

6.13 Printing

System-Spec provides a wide variety of printing options to appease the user. You may access these in Sections C-8 as follows:

A) Press {F10}
(then follow the screen prompts...)

B) Before printing for the first time, you must configure System-Spec for your printer needs, while in the F10 printing screen pop up menu, as follows: select the printer type by pressing {J} (to access the printer menu), and select the printer type that most closely matches your own.

Four printer types are supported as follows:

{A} Epson FX-100 = a typical dot matrix type

{B} Brother HR-35 = a typical daisy wheel type

{C} HP Laserjet = typical older laser types

{D} HP Laserjet III = typical newer laser types

C) Select the left margin location by pressing {K}, and entering the number of blank printer columns you want maintained on the left side of page before type starts.

(Tip: entering {10} works well for most printers and affords enough space for punching of 3 ring binder holes without injuring page type content.)

Note that the "Print page (2 screens)" option means that both the *current screen display* *__plus__* *the next one in sequence* (if any in that Section) will be printed.

6.14 Manipulating Files Stored in File Registers

Files contained in ANY System-Spec "File-Register" (program Section B) may be freely read (if compatible with your software version #), imported, exported, or deleted (all independent of the actual program itself) as follows:

A) Press {B}
(to get to the File Register).

B) To read or import files located in another computer drive location, press {F4} and follow the screen prompts to obtain the desired results.

C) To export (copy) files to another computer drive location, press {F5} and follow the screen prompts to obtain the desired results.

D) To delete existing files, position the cursor over the file to be deleted and press {Delete}, then follow the screen prompts.

(Tips: When in File Register, press {F1} for some interesting and time saving file locating, selection and transfer tricks. I.e., press {Shift} and {F1} simultaneously for related keypad magic. Press {Shift} and {F6} simultaneously for a file search utility.)

6.15 Asterisks ***** For Values/Answers?!

System-Spec inserts asterisks (*****) for any program input value or computed answer that is as yet undefined (or uncomputable) for any reason. This makes it very easy to visually identify items which have yet to be user entered in the course of a given design session.

As given user entries and/or program computations are successfully executed, respective program line item asterisks are replaced with real program values.

The "Mailbox" utility (see #6.11 above) can be used to locate and complete any undefined program lines responsible for **** presence in a given file. This is easily accomplished through repetitive sequential use of the F6 and F3 keys.

6.16 The "Burpfile" Crash Procedure

A program "crash" is something strange and unhappy that occurs when computer software becomes unable to continue to operate (compute) as a result of a bizzare user entry structure the program is unprepared to deal with or presence of an internal program "bug." Unlike most software, System-Spec handles this in a very controlled manner that keeps you totally informed and in control of the crash process.

When a creative user entry procedure manages to sneak around System-Spec's significant line of "anti-crash armor," or an internal bug rears its ugly head (ICK!), the program politely alerts you of the impending crash by informing you of its need to "burp." (Well EXCUUUUUSE ME!)

The "polite" burp announcement contains three "burp numbers"; *please carefully write them down before proceeding...*

With that accomplished, simply press {Enter}, and the program will do three things:

A) It will *automatically save all of your work* to the File Register, giving it a file name of "Burpfile" to allow the nasty crash causing file to be easily identified.

B) It writes the same "burp numbers" (an encoded message as to why the program crashed) on the final line of the Design File's Report Notes. *This message is the key to curing the cause of the crash*; this is why it's critically important to write it down, for without it our Technical Support Crew cannot assist you in preventing crash recurrence! If not written down, any future program crash causes the original "Burpfile" to be overwritten (destroyed) by the File Register's auto-insertion of the latest "crash victim." (Uh - there's only "one bed" in System-Spec's File Register crash victim hospital OK?) The message then becomes lost with the patient, and the doctor doesn't get a chance to provide a cure.

C) It then automatically recovers, reinstalls the program, and returns you to Section A (the main menu screen). This allows you to efficiently continue with a minimum of head scratching and finger action on the keyboard.

The program politely informs you of the above actions during the course of their execution so that you are aware of what's going on.

- END OF 6.0 -

7.0 STYLESHEETING^{tm}

Stylesheet Designing^{tm} is System-Spec's particular specialty, and is *the key* to minimization of user design labor.

7.1 What's a System-Spec Stylesheet^{tm}?

Stylesheets are tools much like templates, patterns, or molds, etc. - used to expedite those dull, redundant tasks which are *common* (but mandatory) to the successful completion of a given work effort which results in some form of final product. If a given task is common to multiple work efforts - manually executing it over and over and over again is a waste of precious time. Those familiar with "desktop publishing" software know just what this is all about!

System-Spec saves you time by allowing you to create (and store) a very wide variety of "system design and/or spreadsheet patterns" (STYLESHEETS) for subsequent repetitive use. System-Spec Stylesheets are made by creating and saving individual Design and/or Spreadsheet Files which contain all information common to a given power system design type.

Common information can consist of any design aspect: clerical and cost data, system formats vis à vis equipment types, climate types, preferred sizing methodologies, quotation formats, design appendix constant groups, designer narrative notes and so on.

7.2 Creating Basic Design Stylesheets^{tm}

The process is very simple, and best explained by example:

EXAMPLE 1: You may wish to create a group of Photogenset^{tm} designs utilizing the *same* gen set, charger, inverter, transfer switch, and battery specifications - then tailor the resulting generic design (STYLESHEET) for individual customers by *varying* the PV Array size employed while also entering the particular customer's site load energy requirements. To accomplish this you merely:

A) create a Design File with a convenient name ("PG-TYPE1" etc.)

B) insert the common design attributes above (gen set, charger, etc.)

C) save the file to the File Register

When you need to complete the design for a given client, just:

D) call up the file ("PG-TYPE1") from the Register

E) assign it a revision # (or entirely new name if you please - see item #6.9 herein)

F) complete the design with the specific client data required

When you save the new client-specific file, you have your custom design in the Register, basically right alongside the original (untouched!) Stylesheet.

The Stylesheeting possibilities are nearly limitless. By using your imagination, you can not only save a tremendous amount of design labor, but ensure (enforce) *absolutely consistent designs* as the end product. Those who supervise an army of "would be designer" employees in a business will instantly appreciate the critical importance of the Stylesheeting concept!

7.3 Stylesheeting Design and/or Quote Appendices

Per item 4.6 and 4.7 herein, at first glance System-Spec appears to limit the designer to use of only 3 potential appendix value sets. Experienced designers may find this a bother, but here's a nifty Stylesheet trick that eliminates it...

You can create multiple appendix value sets to your heart's content by creating Design Files which contain nothing more than a convenient name ("D-APP1," "D-APP2," "Q-APP1," "Q-APP2," etc., ad nauseum!) *and a unique "Current" appendix value set of your preference*. This value set is created by revising either standard "System-Spec," or your own previously created "Default" appendix values while in the respective Appendix of the otherwise empty Design File. The value set thus created is then stored into the File Register via the {F9} save command, where it awaits your future use.

To employ the value set thus stored, in the creation of a given design run, you simply proceed as in #7.2 (D) - (E) above. That's all there is to it. Now you can go plant trees with the spare time you've created for yourself.

7.4 Creating Basic Spreadsheet Stylesheets™

Similar to #7.2 above, but an even greater labor saver.

Go to Section E (i.e, press {E}), and press {F8} to obtain a blank Spreadsheet.

Go to any System-Spec Report (Section D) and, using the "Insert" key {INS}, select those Report items you wish to have routinely presented by this particular Spreadsheet Stylesheet.

Next, go back to Section E and use the "Insert," numeric keypad arrow, "< >" and "Enter" keys to rearrange the data columns as desired to best organize the Spreadsheet for the particular message you wish to convey to the reader.

While you're at it, embellish the Stylesheet with special header and footer text, "User Comments," etc. to really polish it up for future use.

When finished, press {F9} and respond to the multiple screen prompts to properly save your work to the File Register.

Now the Spreadsheet Stylesheet is ready for expedient use. Go the the File register and press {F8} in order to begin selecting whatever files you want entered into the Spreadsheet.

Proceed by moving the screen cursor over to a desired file name, using the "Insert" key once to insert (twice to delete) the file into the Spreadsheet. Repeat as desired until your selections are complete.

Press {F8} again to deactivate the Spreadsheet File Selection Mode.

Now go to Section E, press {F6}, and System-Spec will load all of the noted data for you in seconds flat.

If you wish to save this newly created Spreadsheet (i.e., without overwriting the original Stylesheet!) press {F4} in Section E and rename the file before saving it with the standard "F9" command.

You're finished.

- END OF 7.0 -

- PLEASE NOTE -

MANUAL SECTION #8.0 HAS NOT BEEN INCLUDED HEREIN; IT WILL BE PROVIDED AT A FUTURE (CURRENTLY UNSCHEDULED) DATE.

9.0 FILE REGISTER DETAILS

For general information about the File Register, please refer to item #4.2 and 6.6, 6.7, 6.9 and 6.14 above. The following is more detailed information concerning Register operation and use:

9.1 Using the Register

When in the Register, press the F1 key to access the key command menu and their basic instructions/function descriptions. *By simple trial and error type wandering around you'll learn how to use the Register faster than you could if we told you how to use its basic features here*, so just start hitting keys and observe the results.

9.2 F4 Command: "Select Drive"

F4 is used to allow you to leap to another System-Spec File Register located on a different computer drive than the one in which you are currently located.

This enables you to simply review and/or import files (via the F5 key) into the Register located on your current drive as desired without having to exit the program.

9.3 F5 Command: "Copy File"

"F5" is used to allow you to move (import or export) files between different computer drives. This enables you to import and export files about freely without having to exit the program.

Files can be sent (copied) to a floppy for transfer to backup archives (a dusty shelf somewhere) or to other computers (users) where System Spec is in use. Note that "F5" *copies files*, it does not remove (dislocate) them. ("Removal" is executed only by deleting files with the "Delete" key.)

Actual file copying is accomplished in a *"push forward"* manner only, i.e., you must be in the register you want to retrieve files from in order to use the "F5" key to *push* said files to wherever you want them to be. [Remember, per #9.2 above, the "F4" key is used to *get you into* any desired (remote) Register so that you can then use the "F5" key to *begin pushing* files forward.]

A) Copy File Operation

Before using "F5," you must first consciously select the file(s) you want to copy. This can be done on an individual (file by file) basis or in any grouping desired (where multiple files are to be moved).

"F5" only copies the file upon which the screen cursor is placed, unless the "Insert" key or Shift-Home/Shift-End key combinations are employed.

The "Insert" key can be used to randomly select single or multiple files for copying as desired. [Place cursor over desired file, then press "Insert" key to select files for copying process. A pointer then appears to visually "mark" the selected file for you. Once a given file has been so selected (marked), only pressing the "Insert" key *on it again* causes it to be deselected (omitted) from the copy process, i.e, the "Delete" key does NOT do this.]

Where *block copying of a sequential string* (or strings) of files is desired, the Shift-Home and Shift-End key combinations are available for faster selection of files. These are displayed on the Register menu accessed via simultaneous pressing of the *Shift* and *F1* keys. [Place cursor on first file in a given string, and press *Shift* and *Home* keys simultaneously to establish the string's "starting point." A marker is placed accordingly. Next place cursor over last file in that string, and press *Shift* and *End* keys simultaneously to establish the string's "stopping point." A string of markers is automatically placed to visually identify all files which now comprise the string selected for copying. You can create as many strings as you like. If you wish to deselect a string, just go to its starting point and press *Shift* and *End* keys simultaneously.]

The "F5" key is then used to execute the actual copy task on *all selected (marked) files at once.*

9.4 F3 Command: "Spreadsheet Selection"

"F8" is used to select files for immediate insertion into whatever spreadsheet is currently loaded in the program (note: pressing E will always take you to that "currently loaded" spreadsheet file). "F8" can also be used to simply view files in use in the currently loaded spreadsheet as well.

For details on Spreadsheet operation, refer to manual sections 4.5, 6.8 and 12.0.

- END OF 9.0 -

10.0 WORKSHEET DETAILS

For general information about the Worksheet, please refer to item #4.3 and 6.5 above. The following is more detailed information concerning Worksheet use:

Remember when entering data that the "F2" key can be used to change the units of measure being entered/displayed/used to any of those noted in item #6.10 above.

A) The Worksheet Has a Memory

System-Spec's Worksheet has a unique "memory" feature enabling immediate design file conversion from system type to system type (see Line 1.10 below) with automatic line value entry at Worksheet lines common to respective system types.

The "memory" also comes into operation whevever you change a given line's preselected automatic ("auto select," etc.) sizing entry to another ("user specified," etc.) selection, by depositing the results of said previous selection's computational results onto respective worksheet lines for your consideration/editing requirements. *This permits instant review of program design decisions without having to look in the Report.*

10.1 Section C-1: "Clerical Data"

This is information used to generally identify the design (especially at the beginning of the Report). It includes a "scratch pad area" called "Design Notes" available for misc. info you'd like to note down about the design (to be) performed.

A) Line 1.01 (File Name)

Entry is used as the design file's name when file is saved (stored) to the File Register.

C) Line 1.03 (Revision #)

Entry is placed as a two digit extension to the design file's name. When a file's revision number is changed, the file is stored as a separate (new) file in the File Register. This permits users to create and expediently store a nearly endless variety of design variations from an initial root design file.

I) Line 1.09 (Elevation)

Entry is used for gen set operating altitude deration calculations (where applicable) in conjunction with section F-3 line Kad, and F-5 line RA.

J) Line 1.10 (System Type)

Entry is used to format the body of the Worksheet's content.

Note that you may *instantly convert* a given design file from one system type to another as often as desired at this line. When you convert (by selecting a different system type), System-Spec "remembers" all of your previous system type line values (whether user or program calculated) *until otherwise changed by you.* This is a handy time saver when you want to examine different system types for a given application.

10.2 Section C-2: "Load & System AC Power Transfer Switch Bank Data"

Average daily load data is entered individually for any DC and AC loads the system serves on a season by season basis. DC and AC loads must be entered separately because of their relative efficiency of supply differences. If no load is present, always enter a "0" (i.e., do NOT leave the ***** in place).

E) Lines 2.05 & 2.12 (Max Load Demand)

Entry is required to assist in various computer automated "design rule" checks that attempt to prevent misc. inadvertent component misspecification.

F) Lines 2.06 & 2.13 (Daylight Load Portion)

Entry is required, as in PV systems there is an efficiency difference between loads used concurrently and nonconcurrently with PV source production.

G) Lines 2.07 and 2.14 (Circuit Quantity)

Entry is required for switchgear quotation purposes in the Report.

O) Lines 2.15 & 2.19 (AC Load Supply Means)

Entry is required due to relative system efficiency differences involved in the method of obtaining AC load supply (where applicable).

**Note: In the Gendirect System case, lines 2.15 - 2.18 are used to define the daily gen set run time.*

P) Line 2.16 (Arbitrary Gen Set Operation)

Where applicable, System-Spec calculates required gen set operation as a function of load supply requirements. However, in many systems there are "arbitrary" (i.e., system user controlled) conditions that sponsor gen set operation (such as gen set use to power an arc welder or other large load not factored into lines 2.08 - 2.11). Where this is the case, System-Spec keeps track of this gen set operation through this line's four seasonal entries. **Note: In the Gendirect System case, lines 2.15 - 2.18 are used to define the daily gen set run time.*

Q) Line 2.17 (System Transfer Switch Spec)

System Spec handles two types of AC Power Transfer Switches: "System" and "Gen Set" (see line 3.01 description below).

A "System" transfer switch is that which directly selects between any given AC source and the system load in need of AC supply.

10.3 Section C-3: "Gen Set Bank Data"

Note: The "Gen Set Bank" = the sum of all gen set and gen set to gen set transfer switch equipment utilized by the system (where applicable).

A) Line 3.01 (Quantity)

Where applicable, System-Spec will keep track of up to three (identically sized) gen sets. Where more than one gen set is specified, System-Spec includes one gen set to gen set AC power transfer switch into the Report's component listing for each additional gen set specified. [This is required solely to prevent inadvertent gen set paralleling, and should not be confused with the function of the "System" AC power transfer switch noted in item #10.2(Q) above.]

B) Line 3.02 (Optional Derating)

Entry is used to directly reduce full gen set power rating (example: for use in high ambient air temperature environs).

*Note: Do not derate for altitude as this is accomplished automatically via Section C-1's line 1.09, F-5's line RA, and F-3's line Kad.

D) Line 3.04 (Power Rating)

Enter nominal reference value as shown on gen set OEM spec sheet. (System Spec handles all required derates separately.)

H) Line 3.08 (Fuel Consumption)

Enter nominal reference value as shown on gen set OEM spec sheet. If values are unavailable, use reference data from curves provided in manual section #19.0 herein.

*Note: Where OEM does not provide:

- "no load" figure - use the "50% load" figure x .6 as an estimate
- "25% load" figure - use the "50% load" figure x .8 as an estimate
- "75% load" figure - use the "100% load" figure x .9 as an estimate

N) Line 3.14 (Maintenance Costs)

"Routine maintenance" is that regularly scheduled upkeep such as oil and filter changes, cooling and electrical system checks, belt and bolt tightening, etc.

"Bottom end overhauls" usually involve a concurrent top end overhaul.

Gen Set servicing companies (preferably the one your client uses!) are a good potential source for this type of information.

Q) Line 3.17 (Labor Cost - Replacement)

This cost is added to that for the physical gen set equipment itself when calculating Report line 5.6.

R) Line 3.18 (Maintenance intervals)

This information is often contained in OEM O&M and/or service manuals, or from gen set servicing companies.

Actual values are heavily dependent on equipment quality, design (example: RPM rating), operating environment (example: routine maintenance is two to four times more frequent in dusty environments), and reliability requirements (example: more frequent scheduled service = less frequent unscheduled failures, etc.).

10.4 Section C-4: "Power Inverter Bank Data"

Note: "Inverter Bank" = the sum of all inverter equipment utilized by the system (where applicable).

A) Line 4.01 (Quantity - Unsynchronized Inverter Modules)

An unsynchronized inverter module is an inverter device whose ungrounded ("hot") AC output line is electrically isolated (i.e., not interconnected in any way) from that of any other inverter device in the system.

- Example #1: A pair of <1992 Trace 2.5 kW #2524 Inverters outfitted with a "stacking interface" = *"1" inverter module* of 5.0 kW max. capacity (because they are interconnected to act as one large inverter).

- **Example #2**: Two pairs of Trace 2.5 kW #2524 inverters each outfitted with "stacking interfaces" = "2" *inverter modules* each of 5.0 kW max capacity as noted by Report line #2.31 (because each pair is not electrically interconnected to the other "bank member"), for a net bank total of 10.0 kW (as noted at Report line #2.30).

System-Spec requires all unsynchronized inverters to be of equivalent power rating/general specification.

Similarly to earlier item #10.3(A), System-Spec includes one "System Transfer Switch" into the Report's component listing for each unsynchronized inverter module entered over one.

B) Line 4.02 (30 Minute Rating)

This value is used due to its industry specmanship prevalence, and general suitability/importance to average system application requirements.

D) Line 4.04 (Waveform)

Entry is used for determining relative inverter cost for the Report's quotation/economics. (Sine wave units generally cost more than the other choices.)

E) Line 4.05 (Efficiency)

Enter the efficiency estimated for the type of load served (the lower the power factor, the poorer most inverters' actual operating efficiency) as well as the % of inverter capacity typically in use.

Typical in service values are 10-20% below OEM brochure figures.

Note: Avoid using OEM peak rated claims; these are normally calculated under very ideal conditions which your systems will rarely be subject to.

F) Line 4.06 (Cutoff Threshold)

Entry is used to determine peak battery discharge rates and in System-Spec's "auto select" battery sizing procedure (where applicable).
Note: Value entered should not be below that at which an auxiliary gen set is started (where applicable) *or where load shedding is practiced.* (I.e., enter the lowest permissible one minute battery bus voltage to be regularly experienced.)

10.5 Section C-5: "Gen Set-powered Charger Bank Data"

Note: "Charger Bank" = sum of all charger equipment utilized by the system (where applicable).

A) Line 5.01 (Sizing Method)

- "Auto-select" sizes the charger bank in response to available (i.e., not required for concurrent AC site loads) system derated gen set AC output capacity and section F-3 line Ec (charger efficiency).
- "User-Specified" allows manual value entry, reminding the user of the maximum enterable value which will result in gen set overload prevention under the average operating regime.

10.6 Section C-6: "PV Array Data"

A) Line 6.01 (Contribution)

System-Spec permits ultimate PV Array size specification to be sponsored in one of three unique approaches:

- "User specified" is the approach to use *when you wish to employ the simulation methodology of some third party software program* as opposed to that which System-Spec uses. (Refer to manual section #2.0, items #2.2 and 2.3, for background details.) The values subsequently entered under this case at lines 6.04 - 6.07 *are employed directly in the Report* for lines 4.12 - 4.14, without any postprocessing (qualification) by the program.

- "PV module quantity" is the approach to use when you want to control the PV array size as a function of discrete module quantity alone.

  Note: This is a very common practice when resellers format system packages for marketing purposes.

- "% of system load" is the approach to use when you want to have System-Spec auto size the PV array for you.

  Note: For those who want to employ "safety factors" in array sizing, one easy way is to enter "% of load" values well in excess of "100%."

D) Lines 6.04 - 6.07 (Peak Sunlight Hours)

(Note: This is not applicable in the "User Specified" case of line 6.01.)

A daily "Peak Sunlight Hour" $= 1.0$ kWH/m^2/day
$= 3.6$ MJ/m^2/day

This type of sunlight availability information is widely used and hence readily available. Manual Section #19.0 contains a large selection of geographical maps which provide this information for your general use where a more specific data source is not otherwise available/required.

Note: For systems using mechanical solar trackers, enter hour values which have been enhanced (multiplied) by the % of usable PV output increase the tracker OEM responsibly reports as being provided by the tracker model you will be employing. (Example: Zomeworks Corp. publishes values which have been third party generated/verified as being up to ~17% in "winter," ~27% in "spring/autumn," and ~42% in "summer.")

H) Lines 6.08 - 6.11 (Temperature)

Entry is used to establish an average NOCT for the PV Array.

M) Line 6.16 (Structure type)

Entry is used for PV Array component listing and quoting purposes in the Report.

N) Line 6.17 (Circuit Rating)

Entry is used as a component of DC switchgear quotation in Report.

10.7 Section C-7: "Battery Storage Bank Data"

A) Line 7.01 (Sizing Method)

System-Spec permits three approaches to battery capacity specification:

- "Auto-select" auto sizes the battery as a function of the system's maximum calculated effective battery charge and discharge rates in order to ensure that rate maximums (as established in section F-5 at lines

Trc and Trd) are not exceeded *at any time over the life of the system.*

- "User-specified" allows direct user insertion of a battery capacity.
- "Load Autonomy" auto sizes the battery in order to ensure that the user's subsequently specified autonomy period is delivered *at the end of the battery's useful life* (a direct function of section F-3 line Cbeol) such that the "designed in" autonomy is available for the *entire duration (!) of the system's life.*

  Note: When reviewing the related load autonomy figure provided in the Report at line 4.10, significantly greater autonomy periods will be indicated because line 4.10 *provides average figures over the course of the system's life* (as a direct function of section F-2 line Cba) rather than stating what it will be on the day the battery's life ends.

10.8 Section C-8: "Quotation Data"

H) Line 8.08 (Life)

Entry is utilized directly in calculating Report line items 5.4 - 5.7, 5.10 and 5.11.

10.9 Section C-9: "System Wiring Data"

System-Spec auto sizes and characterizes any wire run of your creation ["Miscellaneous circuits" selection at line 9.01(A)] or any of the Report's prime component item's main wire runs ["System-Spec circuit" selections (B) - (L) at line 9.01] in accordance with 1990 National Electrical Code requirements/provisions. All wire runs are characterized at their maximum expected system operating current level in RMS amperes.

A) Line 9.01 (Circuit ID)

Selection options #(B) and (C) are provided so that you can independently size (*or just spec review!*) the charging source feeder #(B) or load feeder #(C) run to the system battery. Where these runs are physically the same (as is the case with a "net battery feeder"), option #(D) should be used (it sizes according to the maximum potential current flow, i.e., *the greater* of the charging and load feeder currents).

- END OF 10.0 -

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11.0 REPORT DETAILS

For general information about the Report, please refer to item #4.4 above. The following is more detailed information concerning Report operation and use:

11.1 Section D-1: "Clerical Data" and "System Quotation"

The "System Quotation" is generated in response to the Worksheet Section C-8's specification in conjunction with the Quote Appendix and Currency Index values. (Refer also to manual items #14.0 and 15.0.)

K) Line 2.6 (PV Array Cost)

Listed value may include noted PV modules, structures, and array interconnect wiring (the latter via section G-4, line Kpw, which is multiplied against the value of the two former items).

U) Line 2.16 (Gen Set Bank Cost)

Listed value may include noted gen sets and gen set to gen set transfer switches.

AE) Line 2.26 (Max Discharge Rate)

Listed value ("Bdr") is computed for the worst case total battery load RMS current value vs. line 2.25's spec, as permitted by section F-4, lines PD161a and PD161b.

AF) Line 2.27 (Max Charge Rate)

Listed value ("Bcr") is computed for the worst case total battery charging RMS current value vs. line 2.25's spec, as permitted by section F-4, lines PD162a and PD162b.

BB) Line 2.48 (AC Switchgear)

Listed value includes circuit breakers for all AC load circuits (from Worksheet line #2.14) and their related breaker distribution enclosuring (section F-4, line Npae).

BC) Line 2.49 (DC Switchgear)

Listed value includes all circuit breakers for DC load circuits (from Worksheet line #2.07) and their related breaker distribution enclosuring (section F-4, line Npde2), plus all DC service feeder breakers for inverter, charger and PV source circuits and their related breaker service entrance enclosuring (section F-4, line Npde1).

BJ) Line 2.56 (Total Cost)

Listed value is the sample sum of all previous Report lines, as modified by section G-5, line Mst's multiplier (refer to manual item #14.2 for further details).

11.2 Section D-6: "Report Notes"

This is a "scratch pad area" similar to that provided in the worksheet.

It is provided for the designer's use in annotating both the Report's "System Quotation" section (e.g., inclusion of: component brands/part numbers, special system features or logic of operation notes, shipping weights/measures/means, installed equipment footprints, payment terms, etc.), as well as the balance of the Report's "Operating Characteristics" and "Economics" sections.

The individually line numbered format of the program's print copy supports simple and precise Report Note annotation through expedient line # referencing. The Report Notes section is intended to help eliminate the need for any design submittal post processing work (separate letter summaries/proposals, etc.).

11.3 Sections D-7 & D-8: "System Operating Characteristics"

This is the Report section that provides both average daily winter-spring-summer-autumn, as well and as seasonal and annual total data which summarizes system performance. Data is arranged in five vertical seasonal columns with annual values appearing at the rightmost column. The far right hand side of the screen page displays the units effective for the numerical values in each of the line's columns (data cells). Where a given line description (#4.3/4.4, for example) has two sets of values provided, the upper value is the *daily average*, whereas the lower value is the *total for the season* (or year). [Note: Where dual value sets are provided, average daily figures are readily identified by corresponding units expressed as "(units)/day," whereas seasonal and annual totals lack the "/day" unit expression.]

"****" (asterisks) at any given line value denotes either failure to complete a program line entry, or a design error in your work (remember, you can *press F6 to ask the "mailman" what data you've omitted/fouled up*, then press F3 to have him drive you to the problem location in his hot rod mail truck!).

Where line item information is irrelevant to a particular design type, the line's content is automatically blanked from view.

- LOAD DATA...

A) Line 4.1 (Load Energy)

Values are combined AC and DC (generic) energy units, as applicable, for all Worksheet section C-2 defined system loads (lines 2.01 - 2.04 and 2.08 - 2.11). Respective AC and DC net portions of this combined total are provided in lines 4.3 - 4.6.

G) Line 4.7 (Production Required)

Values are that gross amount of energy which must be produced by the system in order to satisfy the site load demand and overcome all normal system efficiency losses (from batteries, chargers, inverters, etc.).

J) Line 4.9 (Shed Setpoint)

Value is from Worksheet section C-7, line 7.09.

K) Line 4.10 (Autonomy)

Value is the average period of time (over the system's life) load will be supported by the system battery when a 100% SOC to "load shed %" level discharge is experienced. [See also manual section 10.7(A).]

- PV PERFORMANCE DATA...

L) Line 4.11 (Capacity at Load)

Value is the actual effective (working) PV array power rating (at 25°C NOCT) experienced in the course of system operation (as opposed to the OEM's maximum spec rating shown on line 2.1).

M) Line 4.12 (Contribution %)

Values are the percentage of line 4.7 provided by the PV source.

Where a "+" appears in front of a *seasonal line value*, it denotes that a greater than numerically indicated % will be provided, but that the program is unable to display the precise (greater) value because the proper minimum PV module max. power point voltage *for that particular season* is not currently entered at Worksheet line 6.15.

Where a "+" appears in front of an *annual line value*, it means the same and/or that one or more seasons are indicating values in excess of "100.0%", denoting that more energy is generated than can be effectively utilized due to the energy storage limitations of the system's battery.

It is important to note that *values exceeding "100.0%" indicate a strong potential for wasted generation capacity* (i.e., inefficient use of the PV source) through regulation (shedding) of the PV source's output capacity (or battery overcharging if a PV regulator is not utilized). Of course values >100% also denote a *corresponding degree of design "safety margin"* (array oversize) in the design for the particular period involved.

N) Lines 4.13 & 4.14 (Energy Generated)

Value is the unit total energy production estimate for the PV array if properly connected to the system's battery.

Where a "+" appears in front of any value, it denotes the same information as noted for line 4.12 above.

- GEN SET PERFORMANCE DATA...

O) Line 4.15 (Capacity at Load)

Value is the actual effective (working) gen set power rating estimate experienced in the course of system operation (as opposed to the OEM's maximum spec rating shown on line 2.7).

P) Line 4.16 (Contribution %)

Values are the percent of line 4.7 provided by the Gen Set source.

Q) Line 4.17 (Capacity Used)

Values are the average percentage of line 4.15 capacity in use when the gen set is running.

Note: Values approaching 100% are generally most desirable, as they indicate more effective and efficient utilization of the gen set's capabilities during its operation cycle.

R) Line 4.18 (Load Portion)

Values are the average percentage of line 4.15 capacity being drawn directly by site (i.e., non-battery charger) AC loads, as defined by Worksheet entries at lines 2.08 - 2.11 in conjunction with lines 2.15, 2.19 and section F-3, lines Klh and Kspi.

S) Line 4.19 (Available for Charging)

Values are the average remaining percentage of line 4.15 capacity available for battery charging after site AC loads (per line 4.18) are provided for.

T) Line 4.20 (Applied to Charging)

Values are the average percentage of line 4.15 capacity actually used for battery charging.

Note: Values approaching that shown on line 4.19 are generally most desirable, as they indicate more effective and efficient utilization of the gen set's capabilities during its operation cycle.

U) Line 4.21 (Regime)

Value is that entered on Worksheet lines 7.10 and 7.11

V) Line 4.22 (Cycles)

Values are total number of gen set start/run/stop events experienced by the system.

Note: Generally, minimizing these figures reduces gen set equipment wear, prolongs gen set (and battery where gen set recharged) life, improves system reliability, and can promote greater overall system energy efficiency.

W) Line 4.23 (Period)

Values are the average time which elapses between gen set starts (i.e., = gen set starting frequency).

Note: This value is never permitted to exceed 720 hours when line 4.24 - 4.26 values are low, as the gen set must be run for a minimum of 30 minutes every 30 days in order to "exercise."

X) Line 4.24 (Time Per Cycle)

Values are the average amount of time the in-service gen set runs once started in response to system need.

Y) Lines 4.25 (Run Time)

Values are the average amount of time the in-service gen set runs per day.

Z) Line 4.26 (Run Time)

Values are the average total amount of time the in-service gen sets run per season (or annually).

AA) Line 4.27 (Duty Cycle)

Values are the average percentage of time the in-service gen set is running.

AB) Line 4.28 (Fuel)

Values are the average daily fuel consumption totals for the gen set bank.

AC) Line 4.29 (Fuel)

Values are the average seasonal (and annual) fuel consumption totals for the gen set bank.

AD) Lines 4.30 and 4.31 (Heat)

Values are the average maximum daily, seasonal (and annual) thermal energy extraction totals for the gen set bank as defined by Report lines 4.28 and 4.29 in conjunction with section F-3, lines Etr and Fed.

These figures are relevant to systems which intend to utilize the natural byproduct thermal energy of gen set operation for site heating loads.

11.4 Section D-9: "System Economics"

This important Report section details how the system design performs (in terms of economics) over its service life, as well as how often gen set and battery bank prime components must be replaced.

A) Line 5.1 (System Life)

Value displayed is as entered on Worksheet line 8.08.

B) Line 5.2 (Gen Life)

Value displayed is the total amount of time the gen set bank can be reasonably expected to stay in useful (economic) operation. This figure is a direct function of Worksheet lines 3.01 and 3.21 vs. Report line 4.26's annual total.

C) Line 5.3 (Battery Life)

Value displayed is that amount of time estimated to elapse before the battery bank can no longer function with that capacity defined by section F-3 line Cbeol (nominally 80% of its original report line 2.24 capacity).

It should be noted that once a battery has achieved the nominal 80% condition above, it is often on the edge of a steep downward performance decline, becoming very prone to individual cell failure, highly difficult to charge (and keep charged), as well as unable to support high rate discharge currents with useful terminal voltages.

The computation performed for battery life accounts for the effects of cycling wear (in conjunction with section F-1 lines BCLf or BCLs), partial state of charge operation, total time in service (in conjunction with section F-4 line Lbm), and average operating temperature (per Worksheet lines 7.02 - 7.05, in conjunction with Section F-2, lines BSL, BSLK1 and BSLK2).

D) Line 5.4 (Gen Set Bank Replacements)

Value displayed is the total of Report line 2.14 generator set quantity *replacements* (i.e., beyond that originally installed with the system) required over the Specified System Service Life (as shown on line 5.1). Example: Where Worksheet line 3.01's value = "2 gen sets," and Report line 5.4 = "3," this means that over the line 5.4 specified service life 2 gen sets will have to be replaced 3 times for a grand total of (3 x 2) = *6 gen set replacements.*

In this context, gen set to gen set transfer switches (where applicable) are omitted from the term "gen set bank" (i.e., they are never replaced).

E) Line 5.5 (Battery Bank Replacements)

Value displayed is the quantity of total Report line 2.24 battery bank *replacements* (i.e., beyond the one originally installed with the system) required over the Specified System Service Life (as shown on line 5.1).

F) Line 5.6 (Gen Set Bank Replacement Cost)

Value displayed is the total material and labor (per Worksheet line 3.17) cost in *present* (Report line 1.3 dated) *currency units* required over the Specified System Service Life to maintain a system functional Gen Set Bank, in the context of line 5.4 description above.

G) Line 5.7 (Battery Bank Replacement Cost)

Value displayed is the total Report line 2.29 material cost in *present* (Report line 1.3 dated) *currency units* required over the Specified System Service Life to maintain a system functional Battery Bank.

H) Line 5.8 (Gen Set Bank Operating Cost)

Value displayed is the total *annual cost* estimate for operating the Gen Set Bank and includes:

- all fuel (per section C-3's line 3.13 and D-8's line 4.29 annual value)

- all maintenance (per section C-3's line 3.14/3.18, and D-8's line 4.26 annual value)

- all overhauls (per section C-3's line 3.15 & 3.16/3.19 & 3.20, and D-8's line 4.26 annual value)

- misc. operating expenses (per section G-3, line Dmgoc)

The line value does not include any equipment depreciation costs.

I) Line 5.9 (System Operating Cost)

Value displayed is the total *annual cost* estimate for operating the system and is calculated as a simple percentage (per section G-4 line KSOC) of the cost of the following system component and labor items, as conditioned by section G-5, line Mst (see also manual item #14.3 herein):

- PV array
- all transfer switches
- charger bank
- battery bank
- inverter bank
- controls
- metering
- misc. BOS
- surge protection
- AC & DC switchgear
- original on-site installation costs

The values for each of the above appear on their respective Report lines in System Quotation sections D-1 through D-5 when an *itemized quote* [per Worksheet line 8.04, selection (A)] is displayed.

J) Line 5.10 (Life Cycle Cost)

Value displayed is the grand total expenditure estimate in *present* (Report line 1.3 dated) *currency units* required over the Specified System Service Life to purchase, operate and maintain a functional system as defined in all previous sections of the Report and includes:

- all Report item #2.0 equipment and labor costs, *whether quoted in the Report or not(!)*

- all Report line 5.6 - 5.9 replacement and operating costs over the Specified System Service Life

- all PV array, charger bank and inverter bank replacement costs (in conjunction with section F-4, lines Lpa, Lc, and Li).

The values for each of the above appear on their respective Report lines in the System Quotation sections D-1 through D-5 when *"All" items* have been selected for quotation [per Worksheet lines 8.01-8.03] and an *"itemized" quote* [per Worksheet line 8.04, selection (A)] is requested.

K) Line 5.11 (Energy Cost)

Value displayed is the estimated net average per unit cost for the system's *site load energy* (per Report line 4.2's annual value) produced over the Specified System Service Life in *present* (Report line 1.3 dated) *currency units*.

The value is conceptually calculated as follows:

(line 5.10 value) ÷ [(line 4.2 annual value) x (line 5.1 value)].

M910424.LJ/mk

- END OF 11.0 -

- PLEASE NOTE -

MANUAL SECTIONS #12.0 AND 13.0 HAVE NOT BEEN INCLUDED HEREIN; THEY WILL BE PROVIDED AT A FUTURE (CURRENTLY UNSCHEDULED) DATE.

14.0 QUOTE APPENDIX DETAILS

For general information about the Quote Appendix, please refer to item #4.7 and 6.12 above. The following is more detailed information concerning Index operation and use:

14.1 General Use

A) The Quote Appendix function is quite straightforward. It utilizes a range of "volume sensitive cost/unit of capacity" figures for modular commodity items such as PV modules, "capacity sensitive cost/unit of capacity vs. type" figures for monolithic commmodity items such as gas vs. diesel engine generators, and straight line item figures for non-commodity items such as design labor.

B) Individual line item multipliers are provided so that users may mark-up or mark-down each Report "System Quotation" line item, #2.6 - 2.56, precisely as desired.

C) Though this form of price quoting is not "100.0% actual" due to artificial "cost vs. size" type step functions in monolithic commodity items (batteries, chargers, gen sets and inverters for example), when properly employed in conjunction with the "Cost tolerance" (line #2.57 of the Report's System Quotation section) the resulting system price quote *range* provides a good, expedient costing tool for general or "budgetary" estimating purposes. (Note that budgetary quoting is typically well over 95% of the average salesperson's quotation work load!)

Where "100.0% of actual" precision quoting is required (typically only after a client is qualified as seriously interested), the normal budgetary approach is first used to zero in on a given design. One can then go through Report items 2.1 - 2.43, *noting down specific prime component types/sizes*, and subsequently select *actual components* from one's normal vendors accordingly. By taking the actual costs of these actual components and calculating their respective actual cost/unit of capacity values, one can then edit respective Quote Appendix lines for these actual figures. This will automatically yield the true selling prices in the Report, keystroke by keystroke, as you enter them. Next, adjust the Report #2.44 - 2.55 line items to actual bid figures for the system scope/sale involved, and your system quotation becomes accurate and complete in short order.

D) It takes a little getting used to, but with practice you'll be amazed at how much faster, more enjoyable and *results oriented* this system costing approach is. The key is *not to worry about the pennies* (e.g., avoid the "penny wise-pound foolish" bidding syndrome; i.e., "don't sweat the small stuff"), rather, focus on the value of *fielding more bids in less time* as a means of increasing gross sales profit. This is the secret the "big guys" use to their significant bottom line advantage; now you too can play!

14.2 The Markup/Markdown Procedure

You'll note that the line item %'s in Section G-5 can be entered as either a "+%" or "-%." Positive %'s serve to increase ("markup") line item values, whereas negative %'s decrease them ("markdown"). Zero % (i.e., "0%") causes the line item to remain "unconditioned" (i.e., unchanged from its raw value).

Mathematically it works as follows: [(% entered/100)+1] x line item $ = Report Displayed Line Item Cost.

Note that System-Spec allows you to create *as many Quote Appendices as you have customers* through its Stylesheeting^{tm} feature (refer to manual selection 7.0 for "how-to" details). As a result, the most convenient way to quote is to load your purchase costs in at each line item unit value in the Quote Appendix, run X # of essentially duplicate files, and then personalize each file with a particular markup % to suit that customer/quote type. By saving each resultant "Quotation Stylesheet^{tm}" to your File Register, it sits ready to go for subsequent high speed use as needed.

14.3 The "Total System Multiplier Markup"

Section G-5 contains acronym "Mst" ("Multiplier - system total"), which is a very handy quote tool. It functions by conditioning *the sum* of Report lines #2.6 - 2.55 in the same manner as other section %'s modify only their respective line items [see related equation at (A) above].

Examples of Mst use:

A) **Show clients a net volume discount over line item pricing for purchasing the entire system from you (through use of a -% figure)**

B) Provide all line item pricing at your cost (with line item values "hidden" via the Worksheet line 8.04 "Non-itemized" selection) and hit the entire package with a global markup (+%) for a one line total cost shown at Report line 2.56.

14.4 The Quote Appendix/Currency Index Interface

(Refer also to manual section 15.0.)

Because the appendix uses the index's currency values as they are exchanged, it is a simple task to not only value equipment items in any currency desired, but to effect global appendix markups (or markdowns) as well through the creation of your own ersatz currency units (inflated or deflated dollars, etc.). A single keystroke from anywhere in the program can then zap all quoted values instantly by any factor desired!

14.5 Special Cases/Questions

A) *Do I Have to Use the Quote Appendix?*

No. Simply answer Quotation Data at Worksheet lines 8.01 - 8.03 as "None" (or skip each line altogether when first filling out the worksheet).

B) *Where Do I Get Quote Appendix Values?*

From your favorite equipment/services supplier's price lists.

Note that System-Spec will print the Quote Appendix as hard copy for you... suppliers with whom you've a strong working relationship may be glad to fill them out for you if requested.

C) *Why Are System-Spec Values For the Quote Appendix All "*****"?*

Equipment prices and markups are anything but "constant"(!); as a result we simply leave that as best completed by the individual designer.

Indeed, the "System-Spec values" selection option provided by the Quote Appendix's "F8" on screen command allows you to purposefully *not define* certain sizes of certain equipment items that, when executing certain high speed (low attention level!) automatic component selection type quotes, *you may want to have flagged* for special manual consideration. (Example: 480 VAC, 3 phase transfer switches at "+400A" are tricky little beasts to nail a value to without some very concentrated homework!) The resulting "*****" at the respective Report lines will efficiently draw your eye to the issue.

- END OF 14.0 -

15.0 CURRENCY INDEX DETAILS

For general information about the Currency Index, please refer to item #4.8 and 6.12 above. The following is more detailed information concerning Index operation and use:

15.1 Syntax, Index Structure and Exchange Rate Format/Control

A) As used herein, "currency values" are the values in the worksheet, quote appendix, report and spreadsheet to which units of currency are ascribed.

B) The domestic currency by which all currency and economic calculations are made is listed at the bottom block of each page on the Currency Index. All the rest of the currencies listed are "foreign" currencies.

C) All exchange rates documented in the Currency Index are given in the user's choice of units of "# of domestic currency units per foreign currency unit," or "# of foreign currency units per domestic currency unit" format. (The format choice is made via the on screen "F2" command.) When the domestic currency is established (via the "Insert" or "Ins" key), ALL of the exchange rates are changed accordingly as a direct function of the current exchange rate of the newly selected domestic currency and the exchange rate format. The "exchange rate" of the domestic currency is always "1.0" by definition, and therefore not displayed on screen.

D) The exchange rate format switch ("F2" command) is provided to enable users to arrange the Index for exchange rate inputs in the form they are most readily available (for example, as listed in the daily newspaper), as well as to accommodate forward and reverse transactioning as desired/required.

15.2 Automatic Currency Conversions and Listing

A) The internal currency of a file is always *stored and calculated* in the units of that file's user established *"domestic currency."* It is, however, *displayed and edited* in the units of the *"selected currency"* (as established via the "Shift" and "F2" simultaneous key command).

B) When a new file is opened by System-Spec, and its internal currency is not found in the existing program's Currency Index, then the new file's internal currency is *automatically added* to the index's listing. Note, of course, that its *rate of exchange* to the existing program's domestic currency is not known. A mail box note is therefore given to prompt the user to establish the necessary exchange rate so that an automatic currency exchange can take place normally. (The flashing mail box symbol is not shown, however, because there is nothing "wrong" with the worksheet design just because the exchange rate is not known.) Failure to provide the requested exchange rate causes the new file to be displayed in its original currency units, and *prevents any user attempt to manually switch to another currency unit* as can otherwise normally be executed.

C) As a result of the above auto currency conversion/listing, *your System-Spec copy* keeps track of the currency of its files properly. The domestic currency can be changed at will. Files can be transmitted from business to business and country to country without concern for the file's internal currency. All that is needed is the current exchange rate between the domestic currency of your System-Spec copy and the new file's internal currency.

15.3 Manual Index Operation & Editing

A) Up to 153 currencies can be entered into the Currency Index. These may include multiple rates for the same currency, such as buy and sell rates, or "ersatz currencies" such as: "cost dollars" (i.e., the cost of goods at the price you pay for them), "resale dollars" (i.e., the cost of goods after you mark them up for sale), "inflated dollars" (i.e., the dollar value of your currency "X years from now"), etc. To add a new currency, simply open up and fill in an unoccupied currency space. You will automatically be asked for all of the currency parameters. The currency will then be placed into the Currency Index in alphabetical order.

B) System-Spec will use any desired symbol for its currency symbols. The program's editing window also allows you to specify the dollar ($), cent (¢), pound (£), yen (¥), peseta (Pt) and guilder (*ƒ*) symbols if desired. International currency symbols, however, should be used when transmitting files to other countries, either on paper or on disk. Such symbols are, for example, "CAD" and "USD" for Canadian and American dollars respectively (NOT "CA$" and "US$"), and "GBP" for British pound sterling (NOT "GP£"), etc.

C) Remember, any foreign currency can be selected at will as the "standby foreign currency" (just place cursor over desired currency and press "F6" when in the Currency Index) or for assignment as the domestic currency (just place cursor over desired currency and press "Ins"). Once established for display, the currency values can be toggled between the domestic and standby foreign currency by pressing the "Shift" and "F2" keys simultaneously anywhere on the worksheet, report, spreadsheet, design or quote appendix.

15.4 Spreadsheet to Currency Index Interface

A) It's important to note that a spreadsheet file itself does not store currency values. Spreadsheets will only display a single currency unit—that which is the *currently selected* currency as dictated by the user's existing Currency Index selection. This of course can be changed as desired, and the Spreadsheet will instantly reflect said change.

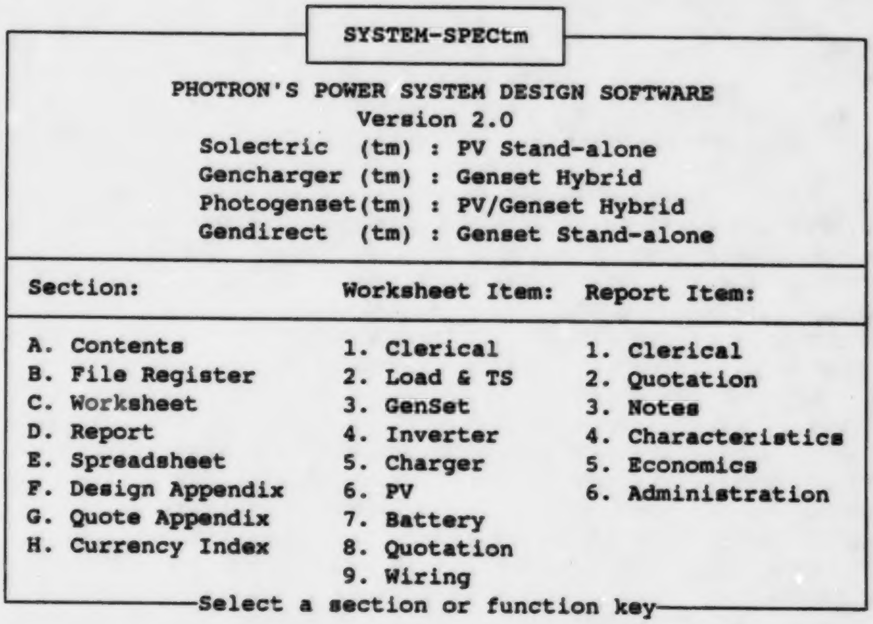
Upon loading Spreadsheet data via the "F6" key command, if a given design file's internal currency cannot be found in the Currency Index, then it is shown on the spreadsheet as having an "error" (via an ">" preceding the file name). Once the missing currency exchange rate is provided to the Currency Index, simply return to the spreadsheet section, press "F6," and the previously "error" containing file will be reloaded with the normal currency exchange taking place (the ">" symbol concurrently disappears).

- END OF 15.0 -

SECTION 18.0

PROGRAM SECTION, DESIGN & SPREADSHEET FILE SAMPLE PRINTOUTS

Section A



```
                  SYSTEM-SPECtm

      PHOTRON'S POWER SYSTEM DESIGN SOFTWARE
                   Version 2.0
        Solectric  (tm) : PV Stand-alone
        Gencharger (tm) : Genset Hybrid
        Photogenset(tm) : PV/Genset Hybrid
        Gendirect  (tm) : Genset Stand-alone

Section:                Worksheet Item:  Report Item:

A. Contents             1. Clerical      1. Clerical
B. File Register        2. Load & TS     2. Quotation
C. Worksheet            3. GenSet        3. Notes
D. Report               4. Inverter      4. Characteristics
E. Spreadsheet          5. Charger       5. Economics
F. Design Appendix      6. PV            6. Administration
G. Quote Appendix       7. Battery
H. Currency Index       8. Quotation
                        9. Wiring
             Select a section or function key
```

```
Revision date: 1991 April 26              oc: MASTER COPY
┌ FILE REGISTER ──────────── Section B-1 ──────────── SYSTEM-SPEC(tm) ┐
│ Drive: C         File Quantity:  63        Disk Space: 2,353,152 bytes │
├──────────────────────────────────────────────────────────────────────┤
│ -SAMPLE .99D │ SAMPLE   .GCD │ TELIDAGC.02D │ UTAH-COM.SLD │           │
│ BOURG-01.00D │ SAMPLE   .GDD │ TELIDAGC.03D │ UTAHCOM1.GCD │           │
│ BOURG-1 .00D │ SAMPLE   .PGD │ TELIDAGC.05D │ UTAHCOM2.PGD │           │
│ BOURG-11.00D │ SAMPLE   .SLD │ TELIDAGD.00D │              │           │
│ BURPFILE.__D │ SASR     .00S │ TELIDAGD.01D │              │           │
│ BURPFILE.__S │ SASR     .GCD │ TELIDAGD.02D │              │           │
│ MANUAL  .10D │ SASR     .GDD │ TELIDAGD.03D │              │           │
│ MANUAL  .98D │ SASR     .PGD │ TELIDAGD.20D │              │           │
│ MANUAL  .99D │ SSS-1    .00D │ TELIDAPG.00D │              │           │
│ PROB4-12.00D │ T-LINE   .00D │ TELIDAPG.01D │              │           │
│ QUOTE   .00D │ T-LINE   .00S │ TELIDAPG.02D │              │           │
│ QUOTEDLR.00D │ T-LINE   .01D │ TELIDAPG.03D │              │           │
│ QUOTEDLR.99D │ T-LINE-1.01D │ TELIDAPG.04D │              │           │
│ QUOTEMFR.00D │ T-LINE-1.02D │ TELIDAPG.05D │              │           │
│ QUOTEMFR.99D │ T-LINE-1.03D │ TELIDAPG.20D │              │           │
│ QUOTENET.00D │ T-LINE-2.01D │ TELIDAPG.LJD │              │           │
│ QUOTENET.99D │ T-LINE-2.02D │ TELIDAPG.YOD │              │           │
│ RR-1    .01D │ T-LINE-2.03D │ UTAH-COM.GCD │              │           │
│ SAMPLE  .00D │ TELIDA-1.00S │ UTAH-COM.GDD │              │           │
│ SAMPLE  .00S │ TELIDAGC.01D │ UTAH-COM.PGD │              │           │
└ Current design file: SAMPLE.PGD ─────────────────────────────────────┘
Shift:  F1-Key pad  F6-File search
```

1.0 Clerical Data

1.01 Design File Name : SAMPLE
1.02 Design Date : 04/13/91
1.03 Design Revision # : SL
1.04 Revision Date : 04/13/91
1.05 Design Company : XYZ COMPANY
1.06 Designer's Name : JOE DESIGNER
1.07 Client Name : SIR (!!!!!!)
1.08 Project Name : PDQ PROJECT
1.09 Site Elevation : 1,000 feet
1.10 System Type : Solectric (tm) : PV Stand-alone
1.11 System Voltage : 24 volts DC (nominal)

DESIGN NOTES...

1.12 HELLO! THIS FILE HAS BEEN GENERATED TO ALLOW YOU TO FLIP THROUGH THE
1.13 PAGES OF THE SYSTEM-SPEC SOFTWARE DESIGN PROGRAM AND BECOME GENERALLY
1.14 FAMILAR WITH PROGRAM CONTENT AND OPERATION. A TOTAL OF FIVE SAMPLE FILES
1.15 HAVE BEEN STORED IN THIS COPY'S FILE REGISTER-ONE FOR EACH BASIC SYSTEM
1.16 TYPE THIS PROGRAM WAS CREATED TO HELP DESIGN, PLUS A SPREADSHEET WHICH
1.17 CONTAINS A DESIGN TRAIT COMPARISON FOR EACH OF THE FOUR FILES/SYSTEM
1.18 TYPES... PLEASE TAKE A MOMENT TO EXPLORE THE PROGRAM THROUGH THESE
1.19 SAMPLE FILES-NOTE THAT SECTION 18 OF THE MANUAL CONTAINS FILE HARD COPY.

2.0 Load & System AC Power Transfer Switch Bank Data

2.01 Required daily DC load energy - winter : 2.97 kWh/day
2.02 - spring : 2.12 kWh/day
2.03 - summer : 1.98 kWh/day
2.04 - autumn : 2.34 kWh/day
2.05 Max. DC load demand : 0.25 kW
2.06 Daylight hours portion of DC load : 40 %
2.07 Quantity of DC load circuits : 5 circuits

2.08 Required daily AC load energy - winter : 5.90 kWh/day
2.09 - spring : 4.87 kWh/day
2.10 - summer : 3.78 kWh/day
2.11 - autumn : 5.10 kWh/day
2.12 Max. AC load demand : 5.00 kW
2.13 Daylight hours portion of AC load : 65 %
2.14 Quantity of AC load circuits : 20 circuits

2.15
2.16 :
2.17 System transfer switch specification : none utilized
2.18 :
2.19 :

3.0 Genset Bank Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Solectric (tm) : PV Stand-alone system.

It is assumed that a generator set is not utilized.

4.0 Power Inverter Bank Data

4.01 Quantity of unsynchronized inverter modules: 2 inverters
4.02 Maximum 30 minute AC output power rating per unsynchronized inverter module : 6.5 kW AC
4.03 AC power output configuration : 120 VAC, 1 phase, 60 Hz
4.04 AC output waveform : quasi-sine
4.05 Average DC to AC conversion efficiency : 85 %
4.06 Low DC input voltage cutoff threshold : 21 volts

5.0 Genset-powered Charger Bank Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Solectric (tm) : PV Stand-alone system.

It is assumed that a charger is not utilised.

6.0 PV Array Data

6.01	PV contribution		: % of load
6.02	Season for "% of load" requirement		: winter
6.03	% of load provided in winter		: 100 %
6.04	Peak sunlight hours	- winter	: 3.5 hours
6.05		- spring	: 5.0 hours
6.06		- summer	: 7.5 hours
6.07		- autumn	: 5.5 hours
6.08	Daytime ambient air temperature	- winter	: 25.0 °F
6.09		- spring	: 55.0 °F
6.10		- summer	: 85.0 °F
6.11		- autumn	: 60.0 °F
6.12			:
6.13			:
6.14	PV module DC ratings	- max. power current	: 2.85 amperes
6.15		- max. power voltage	: 15 volts
6.16	Mounting structure type		: ground mount
6.17	Source circuit DC current rating		: 20 amperes

7.0 Battery Storage Bank Data

7.01 Sizing method : load autonomy
7.02 Average ambient air temperature at battery - winter : 20.0 °F
7.03 - spring : 50.0 °F
7.04 - summer : 75.0 °F
7.05 - autumn : 55.0 °F
7.06 Battery type : flooded

7.07 Load autonomy season : winter
7.08 Load autonomy period : 7 days
7.09 State of charge threshold for - load shed : 10 %
7.10 :
7.11 :

8.0 Quotation Data

8.01 Prime components quoted : all
Battery PV Modules
Inverters PV Mounts

8.02 Miscellaneous components quoted : all industrial
Controls: Industrial Surge Protection
Metering: Industrial Switchgear: AC
Misc. BOS Package Switchgear: DC

8.03 Miscellaneous services quoted : all
Design Labor Factory Preassembly
Drawings: Electrical On-Site Installation
Drawings: Mechanical Owner's Manual

8.04 Quotation format : itemized
8.05 Quotation tolerance : ± 10 %
8.06 Lead time : 90 days
8.07 Expiry period : 30 days
8.08 System life : 20 years

9.0 System Wiring Data

```
9.01  Circuit identification    : PV array - DC output
9.02              - voltage     : 24 volts
9.03              - current     : 119.7 amperes
9.04              - length      : 75 feet
9.05              - loss %      : 2 %
9.06              - environment : enclosed

9.07  Sizing results   - min. 90°C wire size : 2 conductors @ #4/0 AWG copper
9.08                   - max. voltage loss   : 1.87 %
9.09                   - max. voltage drop   : 0.45 volts
```

1.0 CLERICAL DATA

1.1 Client Name : SIR (!!!!!!)
1.2 Project Name : PDQ PROJECT
1.3 Design File : SAMPLE.SL
1.4 System Type : 24 VDC Solectric (tm) : PV Stand-alone
1.5 Designed By : JOE DESIGNER, XYZ COMPANY

Site Elevation : 1,000 feet
Effective Date : 04/13/91

This report was prepared with the aid of **SYSTEM-SPEC(tm)** Power System Design Software. The following figures are nominal design values calculated in accordance with standard industry conditions, except where noted otherwise.

2.0 SYSTEM QUOTATION

PV ARRAY...

2.1	Max. power (Mp) DC output ratings	: 3.591 kW
2.2		: 119.7 amperes
2.3		: 30 volts
2.4	Array is 2 in series x 42 in parallel for a total of	: 84 modules
2.5	Quantity of ground mount mounting structures	: 14
2.6	Total cost	: 25,468 US$

GENSET BANK...

The power supply at PDQ PROJECT
is a Solectric (tm) : PV Stand-alone system.
An engine generator is not utilized.

GENSET-POWERED CHARGER BANK...

The power supply at PDQ PROJECT
is a Solectric (tm) : PV Stand-alone system.
A genset-powered charger is not utilized.

BATTERY STORAGE BANK...

2.24	Flooded capacity ratings at C/6	151.2 kWh
2.25		6,300 Ah
2.26	Max. discharge rate	C/8.5 hours
2.27	Max. charge rate	C/53 hours
2.28	Bank is 12 in series x 6 in parallel for a total of	72 cells
2.29	Total cost	32,054 US$

POWER INVERTER BANK...

2.30	Max. 30 minute AC output power ratings	13 kW
2.31	(per #2.36, each inverter load may not exceed 6.5 kW)	108.3 amperes
2.32		120 VAC
2.33		1 phase
2.34		60 Hz
2.35		quasi-sine
2.36	Quantity of unsynchronized inverters	2
2.37	Total cost	7,098 US$

SYSTEM AC POWER TRANSFER SWITCH BANK...

System AC power transfer switches are not utilized in this system.

MISCELLANEOUS COMPONENTS...

2.44	Controls	995 US$
2.45	Metering	500 US$
2.46	Miscellaneous BOS	500 US$
2.47	Surge Protection	350 US$
2.48	Switchgear: AC	450 US$
2.49	Switchgear: DC	1,127 US$

MISCELLANEOUS SERVICES...

2.50 Design Labor : 500 US$
2.51 Drawings: Electrical : 500 US$
2.52 Drawings: Mechanical : 250 US$
2.53 Factory Pre-assembly : 1,000 US$
2.54 On-site Installation : 3,500 US$
2.55 Owner's Manual : 500 US$

QUOTATION SUMMARY...

2.56 Total system cost (lines 2.1 - 2.55), F.O.B. origin : 74,792 US$
2.57 Cost tolerance : ± 10 %
2.58 Lead time : 90 days
2.59 Expiry period : 30 days

3.0 REPORT NOTES

3.1 HELLO AGAIN! THIS AREA IS RESERVED FOR YOU TO ENTER MISC. INFORMATION
3.2 REGARDING THE SYSTEM QUOTATION, DESIGN, OPERATING CHARACTERISTICS, OR
3.3 OTHER ITEMS YOU WISH TO INCLUDE IN ORDER TO COMPLETE YOUR DESIGN REPORT
3.4 FOR YOUR CLIENT. ONE VERY COMMON USE FOR THIS PAGE IS THE LISTING OF MFR
3.5 PART NUMBERS WHICH SUPPORT/DETAIL THE PREVIOUS QUOTE SECTION'S GENERAL
3.6 COMPONENT LISTINGS. OTHERS INCLUDE: THE ENTRY OF FREIGHT DATA, PHYSICAL
3.7 DIMENSIONS, EQUIPMENT LAYOUT, WARRANTY, SPECIAL CONTROL/METERING FEATURE
3.8 DATA, ETC. THE BASIC IDEA IS TO UTILIZE THIS SECTION TO AVOID THE NEED
3.9 TO PROVIDE ANY OTHER SUBMITTAL DOCUMENTATION BEYOND SPECIFIC MFR PRODUCT
3.10 BROCHURES, (ie: we're trying to give your secretary the day off!).
3.11
3.12 The Design Report has been structured to first summarize the system
3.13 involved, then to proceed in detailing how it operates in service. As
3.14 you may have noticed, each line of System-Spec is numbered for easy
3.15 identification- this makes directing the reader's attention to specific
3.16 areas of interest a simple task. The net result is a software output
3.17 that is more user/reader friendly, and less "canned" in overall appear-
3.18 ance. Your work looks more like YOUR work this way...
3.19

4.0 SYSTEM OPERATING CHARACTERISTICS

LOAD DATA...		Winter	Spring	Summer	Autumn	Annual	Units
4.1	Load energy req'd	8.87	6.99	5.76	7.44	7.26	kWh/day
4.2	(includes all loads)	0.80	0.64	0.53	0.68	2.65	MWh
4.3	Net AC portion	5.90	4.87	3.78	5.10	4.91	kWh/day
4.4		0.53	0.44	0.35	0.47	1.79	MWh
4.5	Net DC portion	2.97	2.12	1.98	2.34	2.35	kWh/day
4.6		0.27	0.19	0.18	0.22	0.86	MWh
4.7	Energy production req'd	10.35	8.18	6.71	8.70	8.48	kWh/day
4.8	(to meet all loads)	0.93	0.74	0.62	0.80	3.10	MWh
4.9	Load shed setpoint					10.0	% BSOC
4.10	Resulting load autonomy	204	366	557	362	373	hours

PV PERFORMANCE DATA...

4.11	Output capacity @ load					2.96	kW DC
4.12	Energy contribution %	100.3	+100	+100	+100	+100	%
4.13	DC energy generated	10.38	+8.18	+6.71	+8.7	+8.48	kWh/day
4.14		0.937	+0.744	+0.618	+0.8	+3.096	MWh

GENSET PERFORMANCE DATA...

The power supply at PDQ PROJECT
is a Solectric (tm) : PV Stand-alone system.
An engine generator is not utilized.

5.0 SYSTEM ECONOMICS

5.1 Specified system service life : 20 years
5.2
5.3 Battery bank service life : +10 years
5.4
5.5 Quantity of battery bank replacements : 1

5.6
5.7 Battery bank replacement cost : 32,054 US$
5.8
5.9 General system operating cost : 720 US$ /year

5.10 System life cycle cost : 121,255 US$
5.11 System energy production cost : 2.29 US$ /kWh

6.0 ADMINISTRATION

6.1 Report Utility

This design report presents a summary of system specifications and resulting performance based on the averages of a wide variety of highly complex, uncertain and dynamic variables provided by both the system user and the system designer. Actual system performance shall therefore vary accordingly.

6.2 Waiver of Liability

Every reasonable effort has been made by all concerned parties to render this design report as accurate as possible in all respects. However under no circumstances shall any such party be required to assume any liability for damages that may be construed as resulting from use of this design report.

6.3 Copyright Notification

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1.0 Clerical Data

1.01 Design File Name : SAMPLE
1.02 Design Date : 04/13/91
1.03 Design Revision # : GC
1.04 Revision Date : 04/13/91
1.05 Design Company : XYZ COMPANY
1.06 Designer's Name : JOE DESIGNER
1.07 Client Name : SIR (!!!!!!)
1.08 Project Name : PDQ PROJECT
1.09 Site Elevation : 1,000 feet
1.10 System Type : Gencharger (tm) : Genset Hybrid
1.11 System Voltage : 24 volts DC (nominal)

DESIGN NOTES...

1.12 HELLO! THIS FILE HAS BEEN GENERATED TO ALLOW YOU TO FLIP THROUGH THE
1.13 PAGES OF THE SYSTEM-SPEC SOFTWARE DESIGN PROGRAM AND BECOME GENERALLY
1.14 FAMILAR WITH PROGRAM CONTENT AND OPERATION. A TOTAL OF FIVE SAMPLE FILES
1.15 HAVE BEEN STORED IN THIS COPY'S FILE REGISTER-ONE FOR EACH BASIC SYSTEM
1.16 TYPE THIS PROGRAM WAS CREATED TO HELP DESIGN, PLUS A SPREADSHEET WHICH
1.17 CONTAINS A DESIGN TRAIT COMPARISON FOR EACH OF THE FOUR FILES/SYSTEM
1.18 TYPES... PLEASE TAKE A MOMENT TO EXPLORE THE PROGRAM THROUGH THESE
1.19 SAMPLE FILES-NOTE THAT SECTION 18 OF THE MANUAL CONTAINS FILE HARD COPY.

2.0 Load & System AC Power Transfer Switch Bank Data

2.01	Required daily DC load energy	- winter :	2.97 kWh/day
2.02		- spring :	2.12 kWh/day
2.03		- summer :	1.98 kWh/day
2.04		- autumn :	2.34 kWh/day
2.05	Max. DC load demand	:	0.25 kW
2.06		:	
2.07	Quantity of DC load circuits	:	5 circuits
2.08	Required daily AC load energy	- winter :	5.90 kWh/day
2.09		- spring :	4.87 kWh/day
2.10		- summer :	3.78 kWh/day
2.11		- autumn :	5.10 kWh/day
2.12	Max. AC load demand	:	5.00 kW
2.13		:	
2.14	Quantity of AC load circuits	:	20 circuits
2.15	AC load is powered by	:	inverter or genset
2.16	Arbitrary daily genset run period	(W,S,S,A):	0, 0, 0, 0 hours
2.17	System transfer switch specification	:	SYSTEM-SPEC selected
2.18		:	
2.19	AC load transfer %	:	100 %

3.0 Genset Bank Data

3.01 Genset quantity : 2 gensets
3.02 Optional output derating factor : 5 %
3.03 Reason for derating : PROPANE FUEL
3.04 AC power rating : 12 kW AC
3.05 Output type : 120/240 VAC, 1 phase, 60 Hz
3.06 Engine speed : 1800 rpm

3.07 Fuel type : propane
3.08 Fuel consumption - at no load : 0.50 US gals/hour
3.09 - at 25% load : 0.60 US gals/hour
3.10 - at 50% load : 0.70 US gals/hour
3.11 - at 75% load : 0.90 US gals/hour
3.12 - at 100% load : 1.10 US gals/hour
3.13 Fuel price : 1.50 US$/US gal

3.14 Maintenance costs - routine maintenance : 100 US$/interval
3.15 - top end overhaul : 1,000 US$/overhaul
3.16 - bottom end overhaul : 2,000 US$/overhaul
3.17 Labor cost of replacing genset bank : 500 US$/replacement
3.18 Maint. intervals - routine maintenance : 200 hours
3.19 - top end overhaul : 2,500 hours
3.20 - bottom end overhaul : 5,000 hours
3.21 - total replacement : 10,000 hours

4.0 Power Inverter Bank Data

4.01 Quantity of unsynchronized inverter modules: 2 inverters
4.02 Maximum 30 minute AC output power rating per unsynchronized inverter module : 6.5 kW AC
4.03 AC power output configuration : 120 VAC, 1 phase, 60 Hz
4.04 AC output waveform : quasi-sine
4.05 Average DC to AC conversion efficiency : 85 %
4.06 Low DC input voltage cutoff threshold : 21 volts

5.0 Genset-powered Charger Bank Data

5.01 Sizing method : automatic
5.02 SYSTEM-SPEC to specify charger bank size.
5.03 :
5.04 :
5.05 :
5.06 :
5.07 :
5.08 :
5.09 :
5.10 :
5.11 :
5.12 :

6.0 PV Array Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Gencharger (tm) : Genset Hybrid system.

It is assumed that a PV array is not utilized.

7.0 Battery Storage Bank Data

7.01 Sizing method : automatic
7.02 Average ambient air temperature at battery - winter : 20.0 °F
7.03 - spring : 50.0 °F
7.04 - summer : 75.0 °F
7.05 - autumn : 55.0 °F
7.06 Battery type : flooded

7.07 SYSTEM-SPEC to specify battery bank size.
7.08 :
7.09 State of charge threshold for - load shed : 10 %
7.10 - genset start : 20 %
7.11 - genset stop : 80 %

8.0 Quotation Data

8.01 Prime components quoted : all
Battery
Chargers
Gensets
Inverters
Transfer Switches: Genset
Transfer Switches: System

8.02 Miscellaneous components quoted : all industrial
Controls: Industrial
Metering: Industrial
Misc. BOS Package
Surge Protection
Switchgear: AC
Switchgear: DC

8.03 Miscellaneous services quoted : all
Design Labor
Drawings: Electrical
Drawings: Mechanical
Factory Preassembly
On-Site Installation
Owner's Manual

8.04 Quotation format : itemized
8.05 Quotation tolerance : ± 10 %
8.06 Lead time : 90 days
8.07 Expiry period : 30 days
8.08 System life : 20 years

9.0 System Wiring Data

9.01 Circuit identification : battery - DC input/output
9.02 - voltage : 24 volts
9.03 - current : 740.2 amperes
9.04 - length : 8 feet
9.05 - loss % : 2 %
9.06 - environment : enclosed

9.07 Sizing results - min. 90°C wire size : 3 conductors @ #4/0 AWG copper
9.08 - max. voltage loss : 0.82 %
9.09 - max. voltage drop : 0.2 volts

1.0 CLERICAL DATA

1.1 Client Name : SIR (!!!!!!)
1.2 Project Name : PDQ PROJECT
1.3 Design File : SAMPLE.GC
1.4 System Type : 24 VDC Gencharger (tm) : Genset Hybrid
1.5 Designed By : JOE DESIGNER, XYZ COMPANY

Site Elevation : 1,000 feet
Effective Date : 04/13/91

This report was prepared with the aid of **SYSTEM-SPEC(tm)** Power System Design Software. The following figures are nominal design values calculated in accordance with standard industry conditions, except where noted otherwise.

2.0 SYSTEM QUOTATION

PV ARRAY...

The power supply at PDQ PROJECT
is a Gencharger (tm) : Genset Hybrid system.
A photovoltaic array is not utilized.

GENSET BANK...

2.7	Max. continuous AC output power ratings	: 12 kW
2.8		: 50 amperes
2.9		: 120/240 VAC
2.10		: 1 phase
2.11		: 60 Hz
2.12		: 1,800 rpm
2.13	Fuel type	: propane
2.14	Quantity of gensets operating alternately	: 2
2.15	Quantity of genset to genset transfer switches	: 1
2.16	Total cost of genset bank	: 13,368 US$

GENSET-POWERED CHARGER BANK...

2.17	Max. DC output power ratings	: 8.2 kW
2.18		: 340 amperes
2.19	Quantity of charger modules operating in parallel	: 2
2.20	AC input power configuration	: 240 VAC
2.21		: 1 phase
2.22		: 60 Hz
2.23	Total cost	: 2,970 US$

BATTERY STORAGE BANK...

2.24	Flooded capacity ratings at C/6	46.8 kWh
2.25		1,950 Ah
2.26	Max. discharge rate	C/2.6 hours
2.27	Max. charge rate	C/5.7 hours
2.28	Bank is 12 in series x 2 in parallel for a total of	24 cells
2.29	Total cost	9,922 US$

POWER INVERTER BANK...

2.30	Max. 30 minute AC output power ratings	13 kW
2.31	(per #2.36, each inverter load may not exceed 6.5 kW)	108.3 amperes
2.32		120 VAC
2.33		1 phase
2.34		60 Hz
2.35		quasi-sine
2.36	Quantity of unsynchronized inverters	2
2.37	Total cost	7,098 US$

SYSTEM AC POWER TRANSFER SWITCH BANK...

2.38	Max. AC output power ratings	26 kW
2.39	(per #2.42, each switch load may not exceed 13 kW)	108 amperes
2.40		240 VAC
2.41		1 phase
2.42	Quantity of system transfer switches	2
2.43	Total cost	1,040 US$

MISCELLANEOUS COMPONENTS...

2.44	Controls	995 US$
2.45	Metering	500 US$
2.46	Miscellaneous BOS	250 US$
2.47	Surge Protection	250 US$
2.48	Switchgear: AC	450 US$
2.49	Switchgear: DC	807 US$

MISCELLANEOUS SERVICES...

2.50 Design Labor : 500 US$
2.51 Drawings: Electrical : 500 US$
2.52 Drawings: Mechanical : 250 US$
2.53 Factory Pre-assembly : 1,000 US$
2.54 On-site Installation : 2,500 US$
2.55 Owner's Manual : 500 US$

QUOTATION SUMMARY...

2.56 Total system cost (lines 2.1 - 2.55), F.O.B. origin : 42,900 US$
2.57 Cost tolerance : ± 10 %
2.58 Lead time : 90 days
2.59 Expiry period : 30 days

3.0 REPORT NOTES

3.1 HELLO AGAIN! THIS AREA IS RESERVED FOR YOU TO ENTER MISC. INFORMATION
3.2 REGARDING THE SYSTEM QUOTATION, DESIGN, OPERATING CHARACTERISTICS, OR
3.3 OTHER ITEMS YOU WISH TO INCLUDE IN ORDER TO COMPLETE YOUR DESIGN REPORT
3.4 FOR YOUR CLIENT. ONE VERY COMMON USE FOR THIS PAGE IS THE LISTING OF MFR
3.5 PART NUMBERS WHICH SUPPORT/DETAIL THE PREVIOUS QUOTE SECTION'S GENERAL
3.6 COMPONENT LISTINGS. OTHERS INCLUDE: THE ENTRY OF FREIGHT DATA, PHYSICAL
3.7 DIMENSIONS, EQUIPMENT LAYOUT, WARRANTY, SPECIAL CONTROL/METERING FEATURE
3.8 DATA, ETC. THE BASIC IDEA IS TO UTILIZE THIS SECTION TO AVOID THE NEED
3.9 TO PROVIDE ANY OTHER SUBMITTAL DOCUMENTATION BEYOND SPECIFIC MFR PRODUCT
3.10 BROCHURES, (ie: we're trying to give your secretary the day off!).
3.11
3.12 The Design Report has been structured to first summarize the system
3.13 involved, then to proceed in detailing how it operates in service. As
3.14 you may have noticed, each line of System-Spec is numbered for easy
3.15 identification- this makes directing the reader's attention to specific
3.16 areas of interest a simple task. The net result is a software output
3.17 that is more user/reader friendly, and less "canned" in overall appear-
3.18 ance. Your work looks more like YOUR work this way...
3.19

4.0 SYSTEM OPERATING CHARACTERISTICS

LOAD DATA...		Winter	Spring	Summer	Autumn	Annual	Units
4.1	Load energy req'd	8.87	6.99	5.76	7.44	7.26	kWh/day
4.2	(includes all loads)	0.80	0.64	0.53	0.68	2.65	MWh
4.3	Net AC portion	5.90	4.87	3.78	5.10	4.91	kWh/day
4.4		0.53	0.44	0.35	0.47	1.79	MWh
4.5	Net DC portion	2.97	2.12	1.98	2.34	2.35	kWh/day
4.6		0.27	0.19	0.18	0.22	0.86	MWh
4.7	Energy production req'd	9.65	7.65	6.28	8.12	7.92	kWh/day
4.8	(to meet all loads)	0.87	0.70	0.58	0.75	2.89	MWh
4.9	Load shed setpoint					10.0	% BSOC
4.10	Resulting load autonomy	62	113	173	111	115	hours

PV PERFORMANCE DATA...

The power supply at PDQ PROJECT
is a Gencharger (tm) : Genset Hybrid system.
A photovoltaic array is not utilized.

GENSET PERFORMANCE DATA...

		Winter	Spring	Summer	Autumn	Annual	Units
4.15	Output capacity @ load					11.4	kW AC
4.16	Energy contribution %	100.0	100.0	100.0	100.0	100.0	%
4.17	Avg. capacity used	75.2	74.5	73.9	74.7	74.6	%
4.18	Direct AC load portion	3.2	2.7	2.1	2.8	2.7	%
4.19	Available for charging	96.8	97.3	97.9	97.2	97.3	%
4.20	Avg applied to charging	72.0	71.9	71.9	71.9	71.9	%
4.21	Typ. operating regime					20/80	% BSOC
4.22	Operating cycles	49.5	29.3	20.7	29.9	130	cycles
4.23	Cycle period	47	83	126	82	76	hours
4.24	Typ. run time per cycle	3.4	4.8	6.0	5.1	4.5	hours
4.25	Avg. run time	1.9	1.6	1.4	1.7	1.6	hours/d
4.26		169	142	124	152	588	hours
4.27	Net duty cycle	7.8	6.5	5.6	6.9	6.7	%
4.28	Fuel req'd	1.6	1.4	1.2	1.4	1.4	USgals/d
4.29		148	123	107	132	510	US gals
4.30	Cogenerable heat	0.60	0.50	0.43	0.52	0.51	therms/d
4.31		54.13	45.05	39.29	48.27	187	therms

5.0 SYSTEM ECONOMICS

5.1	Specified system service life	: 20 years
5.2	Genset bank service life	: +30 years
5.3	Battery bank service life	: +10 years
5.4	Quantity of genset bank replacements	: 0
5.5	Quantity of battery bank replacements	: 1
5.6	Genset bank replacement cost	: 0 US$
5.7	Battery bank replacement cost	: 9,922 US$
5.8	Genset bank operating cost	: 1,628 US$ /year
5.9	General system operating cost	: 270 US$ /year
5.10	System life cycle cost	: 90,798 US$
5.11	System energy production cost	: 1.71 US$ /kWh

6.0 ADMINISTRATION

6.1 Report Utility

This design report presents a summary of system specifications and resulting performance based on the averages of a wide variety of highly complex, uncertain and dynamic variables provided by both the system user and the system designer. Actual system performance shall therefore vary accordingly.

6.2 Waiver of Liability

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6.3 Copyright Notification

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```
1.0   Clerical Data

1.01  Design File Name   : SAMPLE
1.02  Design Date        : 04/13/91
1.03  Design Revision #  : PG
1.04  Revision Date      : 04/13/91
1.05  Design Company     : XYZ COMPANY
1.06  Designer's Name    : JOE DESIGNER
1.07  Client Name        : SIR (!!!!!!)
1.08  Project Name       : PDQ PROJECT
1.09  Site Elevation     : 1,000 feet
1.10  System Type        : Photogenset(tm) : PV/Genset Hybrid
1.11  System Voltage     : 24 volts DC (nominal)

DESIGN NOTES...

1.12  HELLO! THIS FILE HAS BEEN GENERATED TO ALLOW YOU TO FLIP THROUGH THE
1.13  PAGES OF THE SYSTEM-SPEC SOFTWARE DESIGN PROGRAM AND BECOME GENERALLY
1.14  FAMILAR WITH PROGRAM CONTENT AND OPERATION. A TOTAL OF FIVE SAMPLE FILES
1.15  HAVE BEEN STORED IN THIS COPY'S FILE REGISTER-ONE FOR EACH BASIC SYSTEM
1.16  TYPE THIS PROGRAM WAS CREATED TO HELP DESIGN, PLUS A SPREADSHEET WHICH
1.17  CONTAINS A DESIGN TRAIT COMPARISON FOR EACH OF THE FOUR FILES/SYSTEM
1.18  TYPES...  PLEASE TAKE A MOMENT TO EXPLORE THE PROGRAM THROUGH THESE
1.19  SAMPLE FILES-NOTE THAT SECTION 18 OF THE MANUAL CONTAINS FILE HARD COPY.


2.0   Load & System AC Power Transfer Switch Bank Data

2.01  Required daily DC load energy      - winter :     2.97 kWh/day
2.02                                     - spring :     2.12 kWh/day
2.03                                     - summer :     1.98 kWh/day
2.04                                     - autumn :     2.34 kWh/day
2.05  Max. DC load demand                         :     0.25 kW
2.06  Daylight hours portion of DC load           :       40 %
2.07  Quantity of DC load circuits                :        5 circuits

2.08  Required daily AC load energy      - winter :     5.90 kWh/day
2.09                                     - spring :     4.87 kWh/day
2.10                                     - summer :     3.78 kWh/day
2.11                                     - autumn :     5.10 kWh/day
2.12  Max. AC load demand                         :     5.00 kW
2.13  Daylight hours portion of AC load           :       65 %
2.14  Quantity of AC load circuits                :       20 circuits

2.15  AC load is powered by                       : inverter or genset
2.16  Arbitrary daily genset run period  (W,S,S,A): 0, 0, 0, 0 hours
2.17  System transfer switch specification        : SYSTEM-SPEC selected
2.18                                              :
2.19  AC load transfer %                          : 100 %
```

3.0 Genset Bank Data

3.01 Genset quantity : 1 genset
3.02 Optional output derating factor : 5 %
3.03 Reason for derating : PROPANE FUEL
3.04 AC power rating : 12 kW AC
3.05 Output type : 120/240 VAC, 1 phase, 60 Hz
3.06 Engine speed : 1800 rpm

3.07 Fuel type : propane
3.08 Fuel consumption - at no load : 0.50 US gals/hour
3.09 - at 25% load : 0.60 US gals/hour
3.10 - at 50% load : 0.70 US gals/hour
3.11 - at 75% load : 0.90 US gals/hour
3.12 - at 100% load : 1.10 US gals/hour
3.13 Fuel price : 1.50 US$/US gal

3.14 Maintenance costs - routine maintenance : 100 US$/interval
3.15 - top end overhaul : 1,000 US$/overhaul
3.16 - bottom end overhaul : 2,000 US$/overhaul
3.17 Labor cost of replacing genset bank : 500 US$/replacement
3.18 Maint. intervals - routine maintenance : 200 hours
3.19 - top end overhaul : 2,500 hours
3.20 - bottom end overhaul : 5,000 hours
3.21 - total replacement : 10,000 hours

4.0 Power Inverter Bank Data

4.01 Quantity of unsynchronized inverter modules: 2 inverters
4.02 Maximum 30 minute AC output power rating per unsynchronized inverter module : 6.5 kW AC
4.03 AC power output configuration : 120 VAC, 1 phase, 60 Hz
4.04 AC output waveform : quasi-sine
4.05 Average DC to AC conversion efficiency : 85 %
4.06 Low DC input voltage cutoff threshold : 21 volts

5.0 Genset-powered Charger Bank Data

5.01 Sizing method : automatic
5.02 SYSTEM-SPEC to specify charger bank size.
5.03 :
5.04 :
5.05 :
5.06 :
5.07 :
5.08 :
5.09 :
5.10 :
5.11 :
5.12 :

6.0 PV Array Data

6.01 PV contribution : % of load
6.02 Season for "% of load" requirement : summer
6.03 % of load provided in summer : 75 %
6.04 Peak sunlight hours - winter : 3.5 hours
6.05 - spring : 5.0 hours
6.06 - summer : 7.5 hours
6.07 - autumn : 5.5 hours

6.08 Daytime ambient air temperature - winter : 25.0 °F
6.09 - spring : 55.0 °F
6.10 - summer : 85.0 °F
6.11 - autumn : 60.0 °F

6.12 :
6.13
6.14 PV module DC ratings - max. power current : 2.85 amperes
6.15 - max. power voltage : 16.8 volts
6.16 Mounting structure type : ground mount
6.17 Source circuit DC current rating : 20 amperes

7.0 Battery Storage Bank Data

7.01 Sizing method : automatic
7.02 Average ambient air temperature at battery - winter : 20.0 °F
7.03 - spring : 50.0 °F
7.04 - summer : 75.0 °F
7.05 - autumn : 55.0 °F
7.06 Battery type : flooded

7.07 SYSTEM-SPEC to specify battery bank size.
7.08 :
7.09 State of charge threshold for - load shed : 10 %
7.10 - genset start : 20 %
7.11 - genset stop : 80 %

8.0 Quotation Data

8.01 Prime components quoted : all
Battery
Chargers
Gensets
Inverters
PV Modules
PV Mounts
Transfer Switches: System

8.02 Miscellaneous components quoted : all industrial
Controls: Industrial
Metering: Industrial
Misc. BOS Package
Surge Protection
Switchgear: AC
Switchgear: DC

8.03 Miscellaneous services quoted : all
Design Labor
Drawings: Electrical
Drawings: Mechanical
Factory Preassembly
On-Site Installation
Owner's Manual

8.04 Quotation format : itemized
8.05 Quotation tolerance : ± 10 %
8.06 Lead time : 90 days
8.07 Expiry period : 30 days
8.08 System life : 20 years

9.0 System Wiring Data

```
9.01  Circuit identification   : PV array - DC output
9.02            - voltage      : 24 volts
9.03            - current      : 28.5 amperes
9.04            - length       : 50 feet
9.05            - loss %       : 2 %
9.06            - environment  : enclosed

9.07  Sizing results   - min. 90°C wire size : 1 conductor @ #2 AWG copper
9.08                   - max. voltage loss   : 1.89 %
9.09                   - max. voltage drop   : 0.45 volts
```

1.0 CLERICAL DATA

1.1 Client Name : SIR (!!!!!!)
1.2 Project Name : PDQ PROJECT
1.3 Design File : SAMPLE.PG
1.4 System Type : 24 VDC Photogenset(tm) : PV/Genset Hybrid
1.5 Designed By : JOE DESIGNER, XYZ COMPANY

Site Elevation : 1,000 feet
Effective Date : 04/13/91

This report was prepared with the aid of **SYSTEM-SPEC(tm)** Power System Design Software. The following figures are nominal design values calculated in accordance with standard industry conditions, except where noted otherwise.

2.0 SYSTEM QUOTATION

PV ARRAY...

2.1	Max. power (Mp) DC output ratings	: 0.958 kW
2.2		: 28.5 amperes
2.3		: 33.6 volts
2.4	Array is 2 in series x 10 in parallel for a total of	: 20 modules
2.5	Quantity of ground mount mounting structures	: 4
2.6	Total cost	: 7,570 US$

GENSET BANK...

2.7	Max. continuous AC output power ratings	: 12 kW
2.8		: 50 amperes
2.9		: 120/240 VAC
2.10		: 1 phase
2.11		: 60 Hz
2.12		: 1,800 rpm
2.13	Fuel type	: propane
2.14	Quantity of gensets operating alternately	: 1
2.15	Quantity of genset to genset transfer switches	: 0
2.16	Total cost of genset bank	: 6,552 US$

GENSET-POWERED CHARGER BANK...

2.17	Max. DC output power ratings	: 8.2 kW
2.18		: 340 amperes
2.19	Quantity of charger modules operating in parallel	: 2
2.20	AC input power configuration	: 240 VAC
2.21		: 1 phase
2.22		: 60 Hz
2.23	Total cost	: 2,970 US$

BATTERY STORAGE BANK...

2.24	Flooded capacity ratings at C/6	: 50.4 kWh
2.25		: 2,100 Ah
2.26	Max. discharge rate	: C/2.8 hours
2.27	Max. charge rate	: C/5.7 hours
2.28	Bank is 12 in series x 2 in parallel for a total of	: 24 cells
2.29	Total cost	: 10,685 US$

POWER INVERTER BANK...

2.30	Max. 30 minute AC output power ratings	: 13 kW
2.31	(per #2.36, each inverter load may not exceed 6.5 kW)	: 108.3 amperes
2.32		: 120 VAC
2.33		: 1 phase
2.34		: 60 Hz
2.35		: quasi-sine
2.36	Quantity of unsynchronized inverters	: 2
2.37	Total cost	: 7,098 US$

SYSTEM AC POWER TRANSFER SWITCH BANK...

2.38	Max. AC output power ratings	: 26 kW
2.39	(per #2.42, each switch load may not exceed 13 kW)	: 108 amperes
2.40		: 240 VAC
2.41		: 1 phase
2.42	Quantity of system transfer switches	: 2
2.43	Total cost	: 1,040 US$

MISCELLANEOUS COMPONENTS...

2.44	Controls	: 995 US$
2.45	Metering	: 500 US$
2.46	Miscellaneous BOS	: 250 US$
2.47	Surge Protection	: 250 US$
2.48	Switchgear: AC	: 450 US$
2.49	Switchgear: DC	: 853 US$

MISCELLANEOUS SERVICES...

2.50 Design Labor : 500 US$
2.51 Drawings: Electrical : 500 US$
2.52 Drawings: Mechanical : 250 US$
2.53 Factory Pre-assembly : 1,000 US$
2.54 On-site Installation : 5,000 US$
2.55 Owner's Manual : 500 US$

QUOTATION SUMMARY...

2.56 Total system cost (lines 2.1 - 2.55), F.O.B. origin : 46,963 US$
2.57 Cost tolerance : ± 10 %
2.58 Lead time : 90 days
2.59 Expiry period : 30 days

3.0 REPORT NOTES

3.1 HELLO AGAIN! THIS AREA IS RESERVED FOR YOU TO ENTER MISC. INFORMATION
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3.16 areas of interest a simple task. The net result is a software output
3.17 that is more user/reader friendly, and less "canned" in overall appear-
3.18 ance. Your work looks more like YOUR work this way...
3.19

4.0 SYSTEM OPERATING CHARACTERISTICS

LOAD DATA...		Winter	Spring	Summer	Autumn	Annual	Units
4.1	Load energy req'd	8.87	6.99	5.76	7.44	7.26	kWh/day
4.2	(includes all loads)	0.80	0.64	0.53	0.68	2.65	MWh
4.3	Net AC portion	5.90	4.87	3.78	5.10	4.91	kWh/day
4.4		0.53	0.44	0.35	0.47	1.79	MWh
4.5	Net DC portion	2.97	2.12	1.98	2.34	2.35	kWh/day
4.6		0.27	0.19	0.18	0.22	0.86	MWh
4.7	Energy production req'd	9.68	7.80	6.60	8.30	8.09	kWh/day
4.8	(to meet all loads)	0.87	0.71	0.61	0.76	2.95	MWh
4.9	Load shed setpoint					10.0	% BSOC
4.10	Resulting load autonomy	67	122	186	120	124	hours
PV PERFORMANCE DATA...							
4.11	Output capacity @ load					0.71	kW DC
4.12	Energy contribution %	25.5	45.3	80.2	46.8	47.0	%
4.13	DC energy generated	2.47	3.53	5.29	3.88	3.80	kWh/day
4.14		0.223	0.321	0.487	0.357	1.389	MWh
GENSET PERFORMANCE DATA...							
4.15	Output capacity @ load					11.4	kW AC
4.16	Energy contribution %	74.5	54.7	19.8	53.2	53.0	%
4.17	Avg. capacity used	75.2	74.5	73.9	74.7	74.6	%
4.18	Direct AC load portion	3.2	2.7	2.1	2.8	2.7	%
4.19	Available for charging	96.8	97.3	97.9	97.2	97.3	%
4.20	Avg applied to charging	72.0	71.9	71.9	71.9	71.9	%
4.21	Typ. operating regime					20/80	% BSOC
4.22	Operating cycles	34.4	15.0	3.8	14.9	68.0	cycles
4.23	Cycle period	67	163	683	167	145	hours
4.24	Typ. run time per cycle	3.7	5.2	6.4	5.4	4.5	hours
4.25	Avg. run time	1.4	0.85	0.27	0.88	0.84	hours/d
4.26		126	77	24	81	308	hours
4.27	Net duty cycle	5.8	3.5	1.1	3.6	3.5	%
4.28	Fuel req'd	1.2	0.7	0.23	0.8	0.7	USgals/d
4.29		110	67	21	70	268	US gals
4.30	Cogenerable heat	0.45	0.27	0.08	0.28	0.27	therms/d
4.31		40.22	24.59	7.72	25.61	98.14	therms

5.0 SYSTEM ECONOMICS

5.1 Specified system service life : 20 years
5.2 Genset bank service life : +30 years
5.3 Battery bank service life : +10 years
5.4 Quantity of genset bank replacements : 0
5.5 Quantity of battery bank replacements : 1

5.6 Genset bank replacement cost : 0 US$
5.7 Battery bank replacement cost : 10,685 US$
5.8 Genset bank operating cost : 903 US$ /year
5.9 General system operating cost : 377 US$ /year

5.10 System life cycle cost : 83,234 US$
5.11 System energy production cost : 1.57 US$ /kWh

6.0 ADMINISTRATION

6.1 Report Utility

This design report presents a summary of system specifications and resulting performance based on the averages of a wide variety of highly complex, uncertain and dynamic variables provided by both the system user and the system designer. Actual system performance shall therefore vary accordingly.

6.2 Waiver of Liability

Every reasonable effort has been made by all concerned parties to render this design report as accurate as possible in all respects. However under no circumstances shall any such party be required to assume any liability for damages that may be construed as resulting from use of this design report.

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1.0 Clerical Data

```
1.01  Design File Name   : SAMPLE
1.02  Design Date        : 04/13/91
1.03  Design Revision #  : GD
1.04  Revision Date      : 04/13/91
1.05  Design Company     : XYZ COMPANY
1.06  Designer's Name    : JOE DESIGNER
1.07  Client Name        : SIR (!!!!!!)
1.08  Project Name       : PDQ PROJECT
1.09  Site Elevation     : 1,000 feet
1.10  System Type        : Gendirect (tm) : Genset Stand-alone
1.11                     :
```

DESIGN NOTES...

```
1.12  HELLO! THIS FILE HAS BEEN GENERATED TO ALLOW YOU TO FLIP THROUGH THE
1.13  PAGES OF THE SYSTEM-SPEC SOFTWARE DESIGN PROGRAM AND BECOME GENERALLY
1.14  FAMILAR WITH PROGRAM CONTENT AND OPERATION. A TOTAL OF FIVE SAMPLE FILES
1.15  HAVE BEEN STORED IN THIS COPY'S FILE REGISTER-ONE FOR EACH BASIC SYSTEM
1.16  TYPE THIS PROGRAM WAS CREATED TO HELP DESIGN, PLUS A SPREADSHEET WHICH
1.17  CONTAINS A DESIGN TRAIT COMPARISON FOR EACH OF THE FOUR FILES/SYSTEM
1.18  TYPES...  PLEASE TAKE A MOMENT TO EXPLORE THE PROGRAM THROUGH THESE
1.19  SAMPLE FILES-NOTE THAT SECTION 18 OF THE MANUAL CONTAINS FILE HARD COPY.
```

2.0 Load & System AC Power Transfer Switch Bank Data

```
2.01                                              :
2.02                                              :
2.03                                              :
2.04                                              :
2.05                                              :
2.06                                              :
2.07                                              :

2.08  Required daily AC load energy     - winter :     8.87 kWh/day
2.09                                    - spring :     6.99 kWh/day
2.10                                    - summer :     5.76 kWh/day
2.11                                    - autumn :     7.44 kWh/day
2.12  Max. AC load demand                        :     5.50 kW
2.13                                             :
2.14  Quantity of AC load circuits               :       20 circuits

2.15  AC load energy consumption period - winter : 16.0 hours/day
2.16                                    - spring : 16.0 hours/day
2.17                                    - summer : 16.0 hours/day
2.18                                    - autumn : 16.0 hours/day
2.19                                             :
```

3.0 Genset Bank Data

3.01	Genset quantity		3 gensets
3.02	Optional output derating factor		5 %
3.03	Reason for derating		PROPANE FUEL
3.04	AC power rating		12 kW AC
3.05	Output type		120/240 VAC, 1 phase, 60 Hz
3.06	Engine speed		1800 rpm
3.07	Fuel type		propane
3.08	Fuel consumption	- at no load	0.50 US gals/hour
3.09		- at 25% load	0.60 US gals/hour
3.10		- at 50% load	0.70 US gals/hour
3.11		- at 75% load	0.90 US gals/hour
3.12		- at 100% load	1.10 US gals/hour
3.13	Fuel price		1.50 US$/US gal
3.14	Maintenance costs	- routine maintenance	100 US$/interval
3.15		- top end overhaul	1,000 US$/overhaul
3.16		- bottom end overhaul	2,000 US$/overhaul
3.17	Labor cost of replacing genset bank		500 US$/replacement
3.18	Maint. intervals	- routine maintenance	200 hours
3.19		- top end overhaul	2,500 hours
3.20		- bottom end overhaul	5,000 hours
3.21		- total replacement	10,000 hours

4.0 Power Inverter Bank Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.

It is assumed that an inverter is not utilised.

5.0 Genset-powered Charger Bank Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.

It is assumed that a charger is not utilized.

6.0 PV Array Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.

It is assumed that a PV array is not utilized.

7.0 Battery Storage Bank Data

The system type selected in Line 1.10
for PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.

It is assumed that a battery is not utilized.

8.0 Quotation Data

8.01 Prime components quoted : all
Gensets
Transfer Switches: Genset

8.02 Miscellaneous components quoted : all industrial
Controls: Industrial
Surge Protection
Metering: Industrial
Switchgear: AC
Misc. BOS Package

8.03 Miscellaneous services quoted : all
Design Labor
Factory Preassembly
Drawings: Electrical
On-Site Installation
Drawings: Mechanical
Owner's Manual

8.04 Quotation format : itemized
8.05 Quotation tolerance : ± 10 %
8.06 Lead time : 90 days
8.07 Expiry period : 30 days
8.08 System life : 20 years

9.0 System Wiring Data

9.01 Circuit identification : genset to genset transfer switch - AC output
9.02 - voltage : 120 volts
9.03 - current : 50 amperes
9.04 - length : 25 feet
9.05 - loss % : 2 %
9.06 - environment : enclosed

9.07 Sizing results - min. 90°C wire size : 1 conductor @ #8 AWG copper
9.08 - max. voltage loss : 1.33 %
9.09 - max. voltage drop : 1.6 volts

1.0 CLERICAL DATA

1.1 Client Name : SIR (!!!!!!)
1.2 Project Name : PDQ PROJECT — Site Elevation : 1,000 feet
1.3 Design File : SAMPLE.GD — Effective Date : 04/13/91
1.4 System Type : Gendirect (tm) : Genset Stand-alone
1.5 Designed By : JOE DESIGNER, XYZ COMPANY

This report was prepared with the aid of **SYSTEM-SPEC(tm)** Power System Design Software. The following figures are nominal design values calculated in accordance with standard industry conditions, except where noted otherwise.

2.0 SYSTEM QUOTATION

PV ARRAY...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
A photovoltaic array is not utilized.

GENSET BANK...

2.7	Max. continuous AC output power ratings	: 12 kW
2.8		: 50 amperes
2.9		: 120/240 VAC
2.10		: 1 phase
2.11		: 60 Hz
2.12		: 1,800 rpm
2.13	Fuel type	: propane
2.14	Quantity of gensets operating alternately	: 3
2.15	Quantity of genset to genset transfer switches	: 2
2.16	Total cost of genset bank	: 20,184 US$

GENSET-POWERED CHARGER BANK...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
A genset-powered charger is not utilized.

BATTERY STORAGE BANK...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
A battery bank is not utilized.

POWER INVERTER BANK...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
An inverter is not utilized.

SYSTEM AC POWER TRANSFER SWITCH BANK...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
A system AC power transfer switch is not utilized.

MISCELLANEOUS COMPONENTS...

2.44	Controls	: 500 US$
2.45	Metering	: 350 US$
2.46	Miscellaneous BOS	: 500 US$
2.47	Surge Protection	: 150 US$
2.48	Switchgear: AC	: 450 US$
2.49		

MISCELLANEOUS SERVICES...

2.50	Design Labor	: 250 US$
2.51	Drawings: Electrical	: 250 US$
2.52	Drawings: Mechanical	: 125 US$
2.53	Factory Pre-assembly	: 500 US$
2.54	On-site Installation	: 1,500 US$
2.55	Owner's Manual	: 250 US$

QUOTATION SUMMARY...

2.56	Total system cost (lines 2.1 - 2.55), F.O.B. origin	: 25,009 US$
2.57	Cost tolerance	: ± 10 %
2.58	Lead time	: 90 days
2.59	Expiry period	: 30 days

3.0 REPORT NOTES

3.1 HELLO AGAIN! THIS AREA IS RESERVED FOR YOU TO ENTER MISC. INFORMATION
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3.17 that is more user/reader friendly, and less "canned" in overall appear-
3.18 ance. Your work looks more like YOUR work this way...
3.19

4.0 SYSTEM OPERATING CHARACTERISTICS

LOAD DATA...		Winter	Spring	Summer	Autumn	Annual	Units
4.1	Load energy req'd	8.87	6.99	5.76	7.44	7.26	kWh/day
4.2	(includes all loads)	0.80	0.64	0.53	0.68	2.65	MWh
4.3							
4.4							
4.5							
4.6							
4.7							
4.8							
4.9							
4.10							

PV PERFORMANCE DATA...

The power supply at PDQ PROJECT
is a Gendirect (tm) : Genset Stand-alone system.
A photovoltaic array is not utilized.

GENSET PERFORMANCE DATA...

		Winter	Spring	Summer	Autumn	Annual	Units
4.15	Output capacity @ load					11.4	kW AC
4.16	Energy contribution %	100.0	100.0	100.0	100.0	100.0	%
4.17	Avg. capacity used	4.8	3.8	3.1	4.1	4.0	%
4.18							
4.19							
4.20							
4.21							
4.22							
4.23							
4.24							
4.25	Avg. run time	16.1	16.1	16.1	16.1	16.1	hours/d
4.26		1,453	1,465	1,481	1,481	5,881	hours
4.27	Net duty cycle	67.1	67.1	67.1	67.1	67.1	%
4.28	Fuel req'd	8.3	8.3	8.2	8.3	8.3	USgals/d
4.29		753	754	758	763	3,029	US gals
4.30	Cogenerable heat	3.06	3.03	3.02	3.04	3.04	therms/d
4.31		276	276	278	280	1,110	therms

5.0 SYSTEM ECONOMICS

5.1	Specified system service life	: 20 years
5.2	Genset bank service life	: 5.1 years
5.3		
5.4	Quantity of genset bank replacements	: 3
5.5		
5.6	Genset bank replacement cost	: 60,468 US$
5.7		
5.8	Genset bank operating cost	: 12,288 US$ /year
5.9	General system operating cost	: 40 US$ /year
5.10	System life cycle cost	: 332,024 US$
5.11	System energy production cost	: 6.26 US$ /kWh

6.0 ADMINISTRATION

6.1 Report Utility

This design report presents a summary of system specifications and resulting performance based on the averages of a wide variety of highly complex, uncertain and dynamic variables provided by both the system user and the system designer. Actual system performance shall therefore vary accordingly.

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SPREADSHEET FOR SAMPLE SYSTEMS: ILLUSTRATING CHARACTERISTICS VS. SYSTEM TYPE

==============================(press the F6 key)==============================

TABLE 1: Prime Component Ratings...

Report line:	a 1.4	b 2.1	c 2.7	d 2.17	e 2.24	f 2.30	g 2.38		See
	System Type	PV Rating DC kWp	Genset Rating AC kWp	ChgBnk Rating DC kWp	BatBnk Rating C/6kWh	InvBnk Rating kW@30m	TSwBnk Rating kWcomb	Designer's Purchasing Ranking:	Foot Note #
Design File									
SAMPLE .PGD	PG@24V	0.958	12.0	8.2	50.40	13.0	26.0	#1 choice	1.0
SAMPLE .GCD	GC@24V	N/A	12.0	8.2	46.80	13.0	26.0	#2 choice	1.0
SAMPLE .SLD	SL@24V	3.591	N/A	N/A	151.20	13.0	N/A	#3 choice	1.0
SAMPLE .GDD	GD	N/A	12.0	N/A	N/A	N/A	N/A	#4 choice	1.0

==============================(press the F6 key)==============================

TABLE 2: System Operating Characteristics vs. System Type...

Report line:	h 4.1	i 4.10	j 4.12	k 4.16	l 4.17	m 4.26	n 4.29		See
	Load Total kWh/d	Load Auton. hours	Load Total PV %	Load Total Gen %	Genset Output % used	Genset OnTime hours	Genset Fuel US gal	Special Items of Interest:	Foot Note #
Design File	annual	annual	annual	annual	annual	annual	annual		
SAMPLE .PGD	7.26	124	47.0	53.0	74.6	308	268	low noise!	
SAMPLE .GCD	7.26	115	N/A	100.0	74.6	588	510	mod. noise!	
SAMPLE .SLD	7.26	373	+100	N/A	N/A	N/A	N/A	no noise!	
SAMPLE .GDD	7.26	N/A	N/A	100.0	4.0	5,881	3,029	noise&fuel!	2.0

SPREADSHEET FOR SAMPLE SYSTEMS: ILLUSTRATING CHARACTERISTICS VS. SYSTEM TYPE

==========================(press the F6 key)==========================

TABLE 3: System Economics...

	o	p	q	r	s	t	u		
Report line:	2.56	2.57	5.2	5.3	5.8	5.10	5.11		See Foot Note #
Design File	Spec'd System Quote US$	Quote Tol ± %	GenBnk Life years	BatBnk Life years	GenBnk O&M Cost US$/yr	System Life T-Cost US$	System Energy Cost $/kWh	Principal Design Advantage:	
SAMPLE .PGD	46,963	10	+30	+10	903	83,234	1.57	gen'l perf.	3.0
SAMPLE .GCD	42,900	10	+30	+10	1,628	90,798	1.71	cost/perf	4.0
SAMPLE .SLD	74,792	10	N/A	+10	N/A	121.3k	2.29	low maint..	5.0
SAMPLE .GDD	25,009	10	5.1	N/A	12,288	332.0k	6.26	purch.price	6.0

FOOTNOTES

1.0 Designer Ranking has been provided based on a combination of purhase price, cost of ownership over system life, and flexibility in use.

2.0 Note the long hours of gen set operation this design requires to provide less than continuous power availabilty. Also note the large amount of fuel that will have to be delivered (and stored) on the site.

3.0 Overall the Photogenset option provides the "best of both worlds". It is capable of easily providing greatly expanded amounts of daily energy if site needs should change. It is also able to yield critical levels of energy on site if fuel supply is temporarily disrupted for any reason.

4.0 The Gencharger has the advantage of costing about 10% less than the Photogenset, and features dual gen sets for failure redundancy. Note however that it costs over 80% more per year to operate!

5.0 The Solectric is silent in operation, and requires no fuel deliveries to the site, nor frequent maintenance-but is far more costly overall and lacks the ability to deliver long periods of "unplanned for" demand.

6.0 The initial cost is attractively low, but the operating cost is high!

HELLO YET AGAIN! AS YOU CAN SEE FROM THIS SAMPLE SPREADSHEET FILE, THE PROGRAM'S ABILITY TO EXPEDIENTLY DELIVER YOUR PREFFERRED DESIGN OR SALES MESSAGE IS A VERY SIMPLE, YET HANDY ASPECT OF PROGRAM OPERATION INDEED.

Acronym	Description		Value	Units
BCLf	Flooded battery cycle life for depth of discharge (DOD)	- 10% DOD	4,700	cycles
		- 20%	4,000	cycles
		- 30%	3,400	cycles
		- 40%	2,900	cycles
		- 50%	2,450	cycles
		- 60%	2,100	cycles
		- 70%	1,800	cycles
		- 80%	1,500	cycles
		- 90%	1,300	cycles
		- 100%	1,100	cycles
BCLs	Sealed battery cycle life for depth of discharge (DOD)	- 10% DOD	2,800	cycles
		- 20%	2,400	cycles
		- 30%	2,000	cycles
		- 40%	1,700	cycles
		- 50%	1,450	cycles
		- 60%	1,250	cycles
		- 70%	1,050	cycles
		- 80%	900	cycles
		- 90%	750	cycles
		- 100%	650	cycles

Acronym	Description		Value	Units
BSL	Battery shelf life	- flooded type	12.0	years
		- sealed type	12.0	years
BSLk1	Battery shelf life at 50°F vs 77°F reference		165	%
BSLk2	Battery shelf life at 122°F vs 77°F reference		45	%
Cba	Battery capacity rating for age averaging		96.5	%
Cbdr	Battery capacity rating factor for non-standard discharge rates (Standard = C/6)	- C/0.5	40.0	%
		- C/1	57.0	%
		- C/2	73.0	%
		- C/3	83.0	%
		- C/4	90.0	%
		- C/5	95.0	%
		- C/6	100.0	%
		- C/7	104.0	%
		- C/8	106.0	%
		- C/9	108.0	%
		- C/10	110.0	%
		- C/12	112.0	%
		- C/15	114.0	%
		- C/20	116.0	%
		- C/50	119.0	%
		- C/100	120.0	%

Acronym	Description		Value	Units
Cbeol	Battery capacity at end of its life		80.0	%
CBsfc	Charger circuit breaker sizing safety factor		10.0	%
CBsfi	Inverter circuit breaker sizing safety factor		10.0	%
CBsfp	PV array circuit breaker sizing safety factor		30.0	%
Cbt	Battery capacity rating for	- flooded type	0.778	%/°F
	non-77°F operation	- sealed type	0.444	%/°F
CFcrn	Charger rated power capacity factor		80.0	%
Csfh	Charger selection safety factor - oversize		10.0	%
Csfl	Charger selection safety factor - undersize		-10.0	%
Eam	Energy availability mis-match factor		50.0	%
Ec	Charger AC-DC conversion efficiency		80.0	%
El	Genset free capacity loading efficiency		90.0	%
Etr	Combustion heat recovery efficiency		40.0	%
Fed	Energy density	- gasoline	1.272	therms/US gal
		- liquid propane	0.916	therms/US gal
		- #2 Diesel	1.376	therms/US gal
Ip	Current per circuit breaker pole		100	amperes
Kad	Genset elevation derating factor		4.0	%/1000 feet
Klh	Hours/day when "most" load power is required		16.0	hours/day
Kspi	Nominal site power change when genset operating		0.0	%
Kvlir	IR voltage loss design factor		4.0	%

Acronym	Description		Value	Units
Lbm	Life - battery bank, maximum limit		10.0	years
Lc	Life - charger bank		20.0	years
Lgm	Life - genset bank, maximum limit		30.0	years
Li	Life - inverter bank		20.0	years
Lpa	Life - PV array		20.0	years
Ndays	Length of design season	- winter	90.25	days
		- spring	91.00	days
		- summer	92.00	days
		- autumn	92.00	days
Nmm	Capacity of mounting structure	- ground type	6	modules
		- roof type	6	modules
		- pole type	6	modules
Npae	Capacity of AC load distribution enclosure		10	positions
Npde1	Capacity of DC service entrance enclosure		15	positions
Npde2	Capacity of DC load distribution enclosure		12	positions
PD161a	Parameter Disable for inverter DC current @ Bdr		1	
PD161b	Parameter Disable for DC load current @ Bdr		1	
PD162a	Parameter Disable for PV DC current @ Bcr		1	
PD162b	Parameter Disable for charger DC current @ Bcr		1	
PFc	Charger input power factor		0.80	
PHci	Charger AC input		1	phase

Acronym	Description	Value	Units
PLd	PV energy loss due to cell degradation	5.0	% in lifetime
PLms	PV energy loss due to mismatch and soiling	5.0	%
PLs	PV energy loss due to shading	3.0	%
RA	Genset manufacturer's reference elevation	1,000	feet
RTp	Non-generating (parasitic) genset run-time	0.10	hours/cycle
SFK1	PV max. power voltage selector	125.0	%
Trc	Battery charge rate	3.0	hours
Trd	Battery discharge rate	1.0	hour
Vbca	Average battery voltage under charge by genset	2.290	volts/cell
Vbcap	Average battery voltage under charge by PV	2.240	volts/cell
Vbcf	Final battery voltage under charge	2.400	volts/cell
Vbda	Average battery voltage under discharge	1.925	volts/cell
Vdpc	Voltage drop in PV controls - @ ≤ 32 V	0.50	volts DC
	- @ > 32 V	1.00	volts DC
Vci	Charger AC input voltage	240	volts AC
Vllc	DC load low voltage tolerance	1.750	volts/cell
Vlpt	PV max. power voltage loss	0.206	%/°F
Vmpc	PV cell max. power point voltage	0.470	volts DC
Vpcn	Nominal battery cell voltage	2.000	volts/cell

Acronym	Description		Value	Units
Dae	Cost of AC load distribution enclosure		75	US$
Dap	Cost of AC load circuit breaker pole		15.00	US$
Db	Flooded battery costs (at C/6 ratings)	- 0 to 100 Ah	550	US$/kWh
		- 100+ to 300	354	US$/kWh
		- 300+ to 600	248	US$/kWh
		- 600+ to 1200	212	US$/kWh
		- 1200+	220	US$/kWh
	Sealed battery costs (at C/6 ratings)	- 0 to 100 Ah	972	US$/kWh
		- 100+ to 300	590	US$/kWh
		- 300+ to 600	438	US$/kWh
		- 600+ to 1200	362	US$/kWh
		- 1200+	358	US$/kWh
Dc	Charger costs (at max. ratings)	- 0 to 1 kW DC	886	US$/kW
		- 1+ to 2	662	US$/kW
		- 2+ to 3.5	474	US$/kW
		- 3.5+ to 6	364	US$/kW
		- 6+	330	US$/kW

Acronym	Description		Value	Units
Dde1	Cost of DC service entrance enclosure		228	US$
Dde2	Cost of DC load distribution enclosure		228	US$
Ddp1	Cost of DC service breaker pole		23.00	US$
Ddp2	Cost of DC load circuit breaker pole		15.00	US$
Dg	Gasoline/propane genset costs (at mfr. ratings)	- 0 to 2.5 kW AC	1,069	US$/kW
		- 2.5+ to 4	866	US$/kW
		- 4+ to 6.5	667	US$/kW
		- 6.5+ to 15	546	US$/kW
		- 15+ to 30	417	US$/kW
		- 30+ to 60	298	US$/kW
		- 60+	253	US$/kW
	Diesel genset costs (at mfr. ratings)	- 0 to 3.8 kW AC	1,584	US$/kW
		- 3.8+ to 7.5	948	US$/kW
		- 7.5+ to 15	714	US$/kW
		- 15+ to 30	519	US$/kW
		- 30+ to 60	294	US$/kW
		- 60+ to 120	202	US$/kW
		- 120+	172	US$/kW

Acronym	Description		Value	Units
Di	Square/quasi-sine wave	- 0 to 0.5 kW AC	902	US$/kW
	inverter costs	- 0.5+ to 3.5	512	US$/kW
	(at max. 30 min.	- 3.5+ to 12.5	546	US$/kW
	mfr. ratings)	- 12.5+ to 25	546	US$/kW
		- 25+	546	US$/kW
	Sine wave	- 0 to 0.5 kW AC	1,710	US$/kW
	inverter costs	- 0.5+ to 3.5	1,086	US$/kW
	(at max. 30 min.	- 3.5+ to 12.5	1,216	US$/kW
	mfr. ratings)	- 12.5+ to 25	1,216	US$/kW
		- 25+ to 50	1,216	US$/kW
		- 50+ to 100	1,216	US$/kW
		- 100+	1,216	US$/kW
Dm	PV mount quote	- ground type	200	US$ each
		- roof type	120	US$ each
		- pole type	68	US$ each
Dmgoc	Miscellaneous genset annual operating costs		100	US$/year

Acronym	Description		Value	Units
Dp	PV module costs	- 0 to 0.5 kW DC	7,500	US$/kW
	(at max. output	- 0.5+ to 1	7,000	US$/kW
	power rating)	- 1+ to 2.5	6,500	US$/kW
		- 2.5+ to 5	6,250	US$/kW
		- 5+	6,000	US$/kW
Dt	System transfer	- 0 to 30 amperes	50	US$/kW
	switch costs	- 30+ to 100	40	US$/kW
		- 100+ to 200	35	US$/kW
		- 200+ to 400	*******	US$/kW
		- 400+	*******	US$/kW
Dtg	Genset/genset transfer	- 0 to 30 amperes	50	US$/kW
	switch costs	- 30+ to 100	22	US$/kW
		- 100+ to 200	44	US$/kW
		- 200+ to 400	*******	US$/kW
		- 400+	*******	US$/kW
Kpw	PV wiring cost		1.0	%
Ksoc	System operating cost factor		1.0	%/year

Acronym	Description	Value	Units
Mb	Battery markup	0.0	%
Mbos	BOS package markup	0.0	%
Mc	Charger markup	0.0	%
Mcon	Controls markup	0.0	%
Mdl	Design labor markup	0.0	%
Mde	Electrical drawings markup	0.0	%
Mdm	Mechanical drawings markup	0.0	%
Mfp	Factory pre-assembly markup	0.0	%
Mg	Genset markup	0.0	%
Mi	Inverter markup	0.0	%
Mm	PV mount markup	0.0	%
Mmet	Metering markup	0.0	%
Moi	On-site installation markup	0.0	%
Mom	Owner's manual markup	0.0	%
Mp	PV module markup	0.0	%
Ms	Surge protector markup	0.0	%
Msa	AC switchgear markup	0.0	%
Msd	DC switchgear markup	0.0	%
Mst	Total system multiplier markup	0.0	%
Mtg	Genset/genset transfer switch markup	0.0	%
Mts	System transfer switch	0.0	%

Acronym	Description	Value	Units
Qbos	BOS package quote	250	US$
Qcc	Commercial controls total quote	500	US$
Qci	Industrial controls total quote	995	US$
Qdl	Design labor quote	500	US$
Qde	Electrical drawings quote	500	US$
Qdm	Mechanical drawings quote	250	US$
Qfp	Factory pre-assembly quote	1,000	US$
Qmc	Commercial metering quote	250	US$
Qmi	Industrial metering quote	500	US$
Qoi	On-site installation quote	5,000	US$
Qom	Owner's manual quote	500	US$
Qs	Surge protector quote	250	US$

Name of currency	Symbol	#of Dec	ExchRate .../US$	Symbol position	Radix mark	Separator mark
Australian dollar	AU$	2	1.277425	prefix	.	,
Austrian schilling	ATS	2	10.72426	prefix	,	.
Bahamian dollar	BS$	2	0.998289	prefix	.	,
Bahraini dinar	BHD	2	0.377911	prefix	.	,
Barbadian dollar	BB$	2	2.024289	prefix	.	,
Belgian franc	BEF	2	31.41965	suffix	,	.
Bermudian dollar	BE$	2	0.998289	prefix	.	,
Brazilian cruzerio	BRC	2	102.5308	prefix	.	,
British pound sterling	GP£	2	0.513353	prefix	.	,
Bulgarian lev	BGL	2	2.760350	suffix	,	.
Canadian dollar	CA$	2	1.166800	prefix	.	,
Chinese renminbi	CHR	2	4.733469	suffix	.	,
Columbian peso	COP	0	545.4885	prefix	,	.
Czechoslovakian koruna	CSK	2	24.28809	suffix	,	.
Danish krone	DKK	2	5.825262	suffix	,	.
Dutch guilder	NLƒ	2	1.712106	suffix	,	.
East Caribbean dollar	EC$	2	2.701551	prefix	.	,
Domestic currency:						
United States of America dollar	US$	2		suffix	.	,

Name of currency	Symbol	#of Dec	ExchRate .../US$	Symbol position	Radix mark	Separator mark
Fijian dollar	FJ$	2	1.428676	prefix	,	.
Finnish mark	FIM	2	3.626982	suffix	,	.
French franc	FRF	2	5.084096	prefix	,	.
German mark	DEM	2	1.519073	prefix	,	.
Greek drachma	GRD	0	154.2570	suffix	,	.
Guyanese dollar	GY$	2	44.80799	prefix	.	,
Hong Kong dollar	HK$	2	7.789052	prefix	.	,
Hungarian forint	HUF	2	61.43316	suffix	,	.
Indian rupee	INR	0	18.18295	suffix	.	,
Indonesian rupiah	IDR	0	1,875.88	prefix	.	,
Iraqi dinar	IQD	2	0.311545	suffix	,	.
Irish pound	IE£	2	0.570116	suffix	,	.
Israeli shekel	ILS	2	2.022885	suffix	.	,
Italian lira	ITL	0	1,137.23	suffix	,	.
Jamaican dollar	JM$	2	7.820375	prefix	.	,
Japanese yen	JP¥	0	129.1994	suffix	,	.
Kenyan shilling	KES	2	22.45401	prefix	.	,
Domestic currency:						
United States of America dollar	US$	2		suffix	.	,

Name of currency	Symbol	#of Dec	ExchRate .../US$	Symbol position	Radix mark	Separator mark
Korean won	KPW	2	716.7076	suffix	,	.
Kuwaiti dinar	KWD	2	0.288448	suffix	.	,
Lebanese pound	LBE	0	776.8309	suffix	,	.
Malaysian ringgitt	MYR	2	2.707193	suffix	,	.
Mexican peso	MXP	0	2,917.00	suffix	.	,
New Zealand dollar	NZ$	2	1.627563	prefix	.	,
Norwegian krone	NOK	2	5.931876	suffix	,	.
Pakistani rupee	PKR	2	21.73217	suffix	,	.
Philippino peso	PHP	2	26.06268	suffix	,	.
Polish zloty	PLZ	0	9,563.93	suffix	,	.
Portugese escudo	PTE	0	134.3002	suffix	,	.
Romanian leu	ROL	2	19.84219	suffix	,	.
Russian ruble	SUR	2	2.453838	suffix	,	.
Saudia Arabian riyal	SAR	2	3.759021	suffix	.	,
Singaporan dollar	SG$	2	1.710098	prefix	.	,
South African rand	ZAR	2	2.539835	suffix	.	,
Spanish peseta	ESR	2	95.49844	suffix	,	.
Domestic currency:						
United States of America dollar	US$	2		suffix	.	,

Name of currency	Symbol	#of Dec	ExchRate .../US$	Symbol position	Radix mark	Separator mark
Swedish krona	SEK	2	5.639439	suffix	,	.
Swiss franc	CHF	2	1.289567	suffix	,	.
Taiwanese dollar	TW$	2	27.13551	prefix	.	,
Tanzanian shilling	TZS	0	195.6405	suffix	.	,
Thai baht	THB	2	25.08546	suffix	,	.
Trinidad and Tobago dollar	TT$	2	4.255288	prefix	.	,
Turkish lira	TRL	0	2,771.50	suffix	,	.
United Arab Emirates dirham	UED	2	3.681919	suffix	.	,
Venezuelan bolivar	VEB	2	49.92085	suffix	.	,
Yugoslavian dinar	YUD	2	10.64599	prefix	,	.
Domestic currency:						
United States of America dollar	US$	2		suffix	.	,

SECTION 19.0

REFERENCE MATERIAL

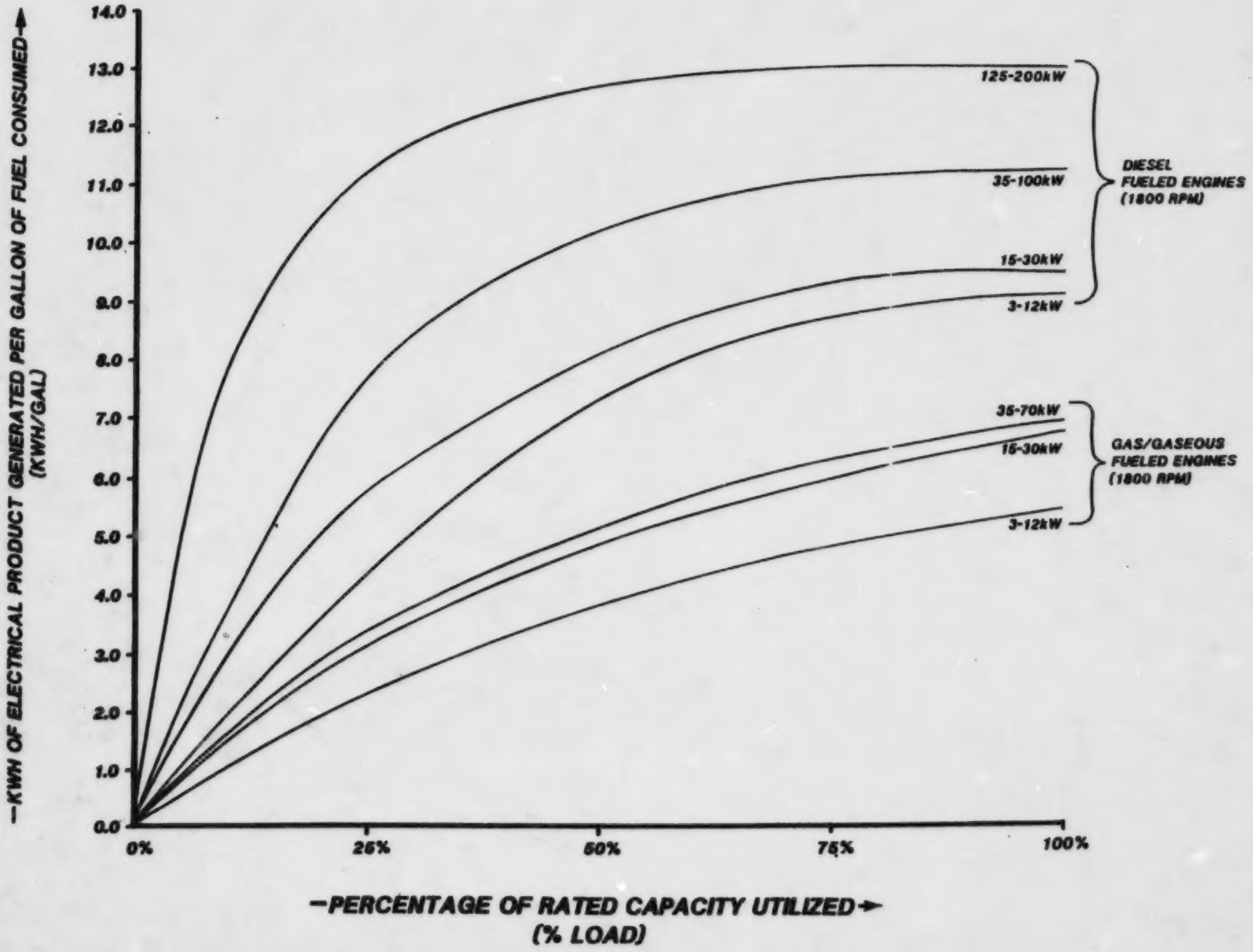

FIGURE F1: GEN SET FUEL EFFICIENCY VS CAPACITY UTILIZED

Size Class: 3 To 200kW (Source: Mfr's Published Data For ONAN Gen Sets)

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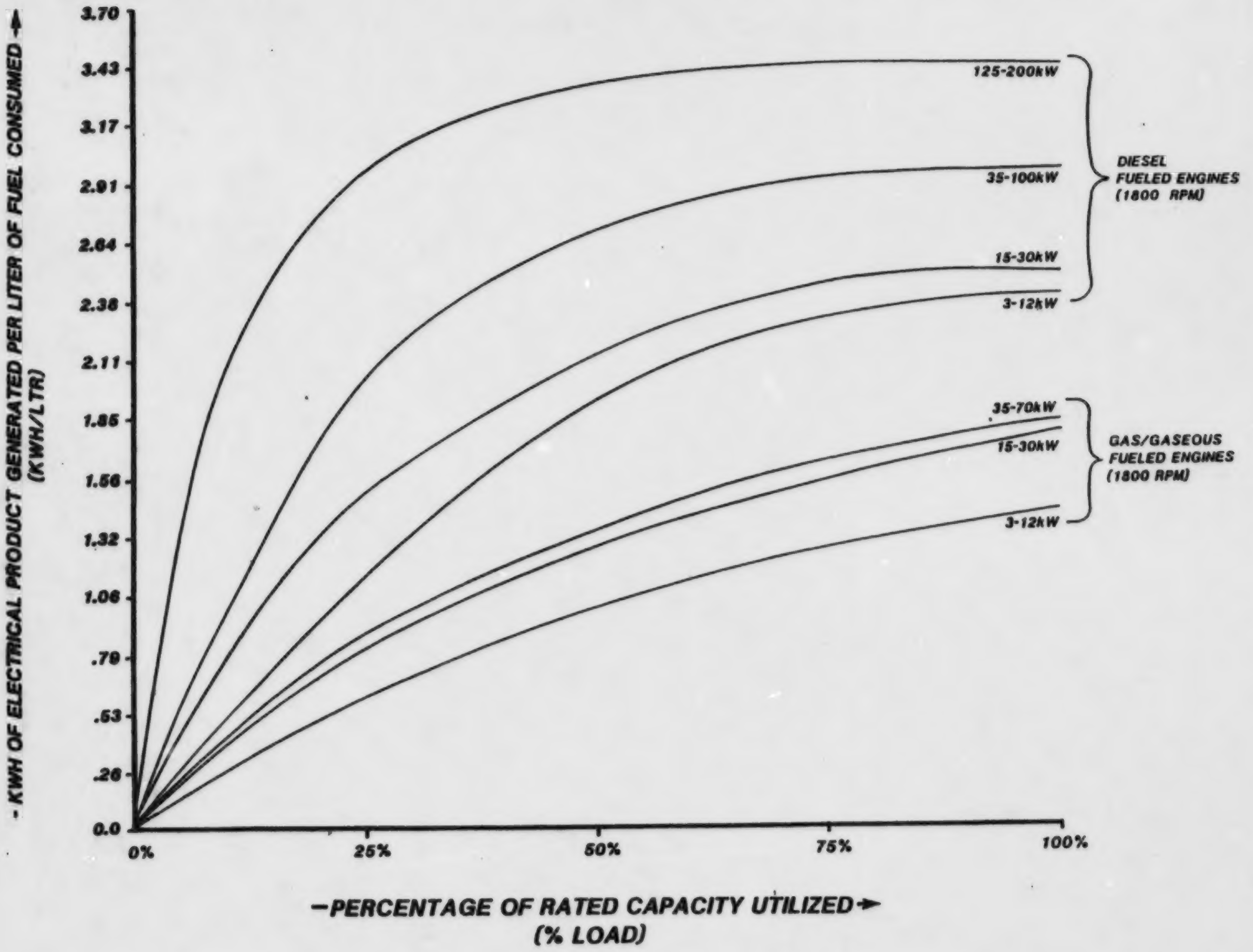


FIGURE F2: GEN SET FUEL EFFICIENCY VS CAPACITY UTILIZED

Size Class: 3 To 200kW (Source: Mfr's Published Data For ONAN Gen Sets)

©Photron 1988

U.S. SUNLIGHT
RESOURCE CONTOUR MAPS

Sunlight Availability vs. Season vs. Collector Tilt Angle

Map Data

- origin: SERI
- published by: Photron, Inc. 1983
- units: kWH/m^2/day (=peak sun hours/day)
- tilt angle is measured up from horizontal (0°)
- "winter" provides data from worst case season month
- "summer" provides data from best case season month
- "yearly average" provides data from the average of all spring and autumn months

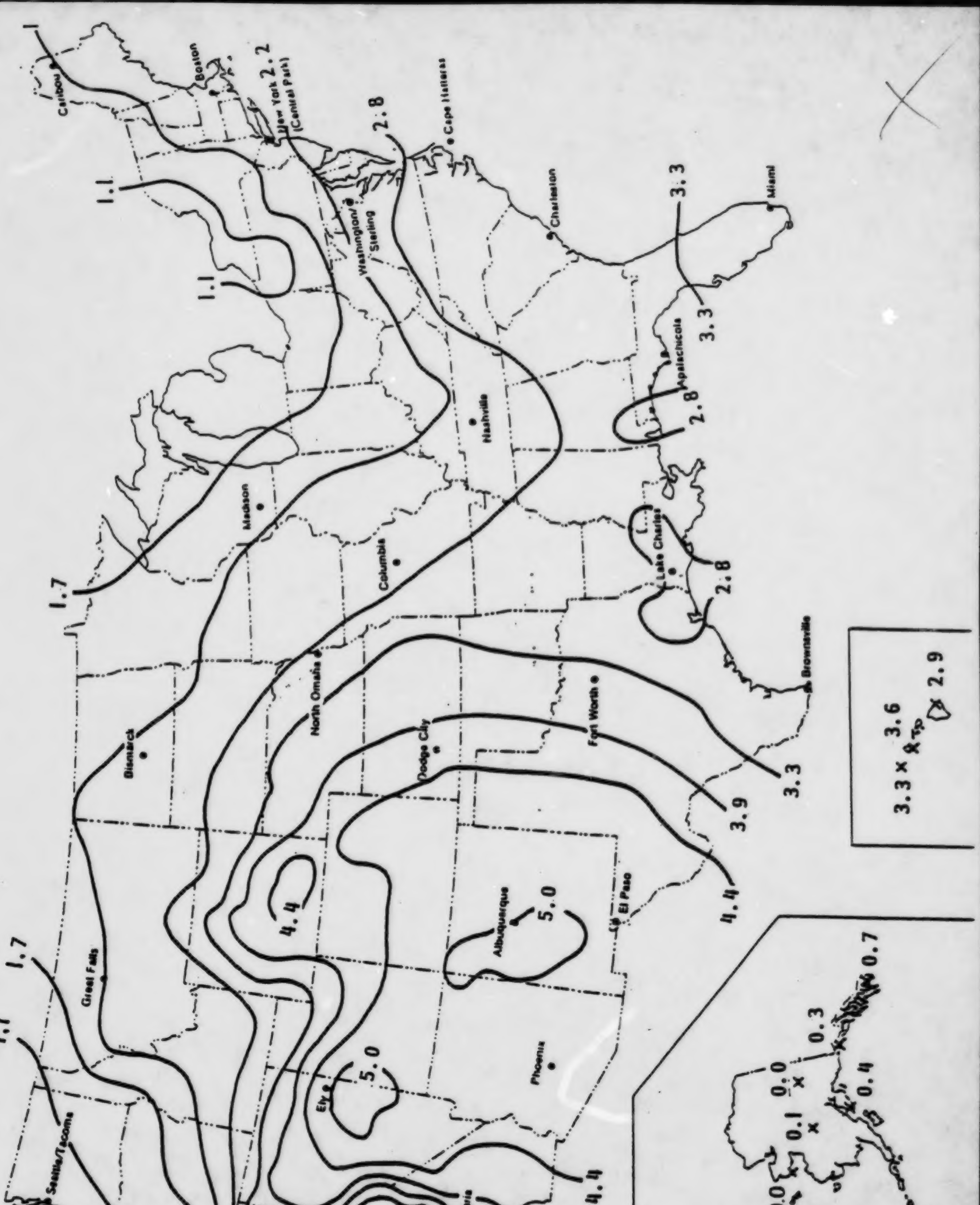


FIG #: S1
SEASON: WINTER
ANGLE: 90°
UNITS: kWH/m^2/day (= peak-sun hours/day)

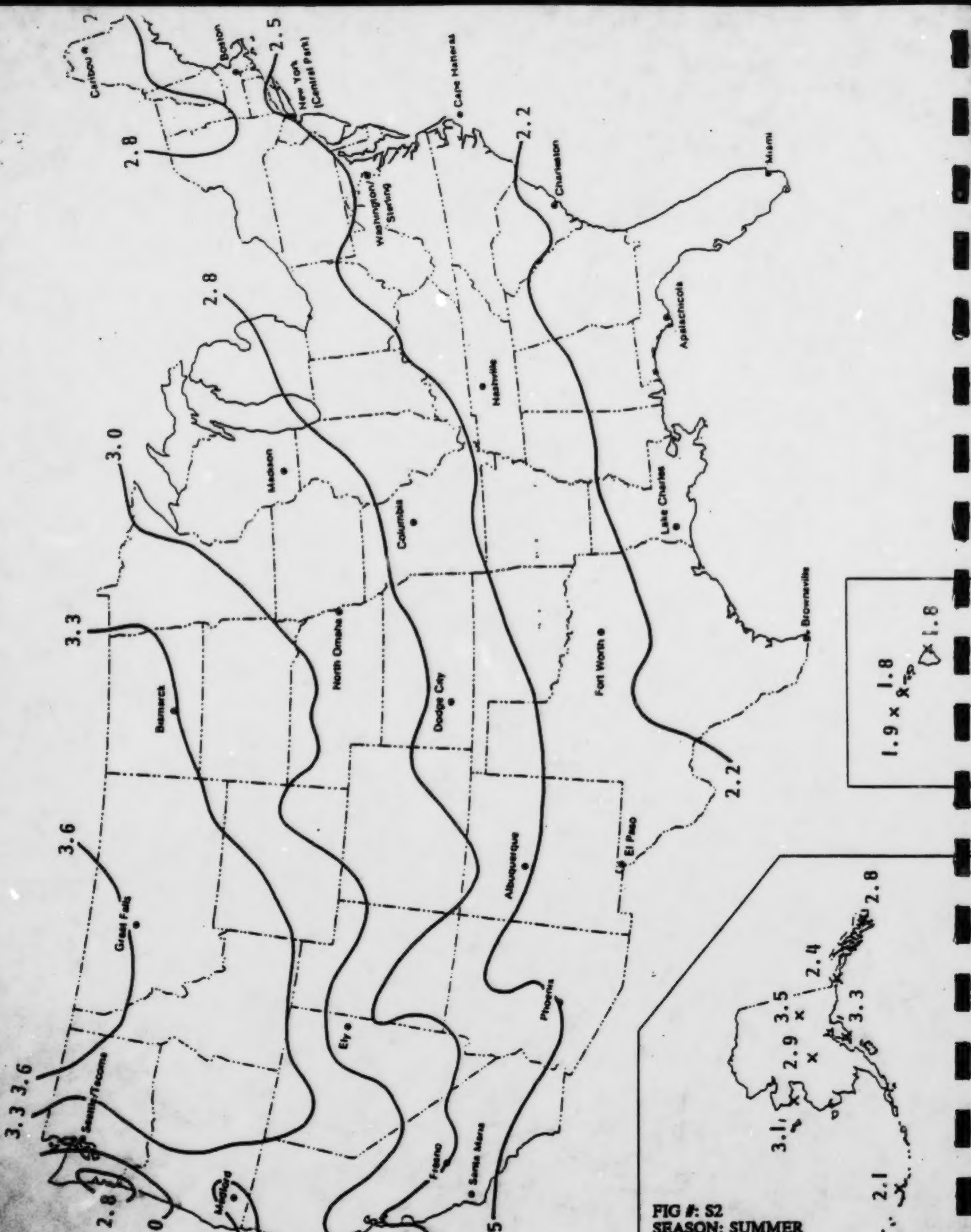


FIG #: S2
SEASON: SUMMER
ANGLE: 90°
UNITS: kWH/m^2/day (= peak sun hours/da

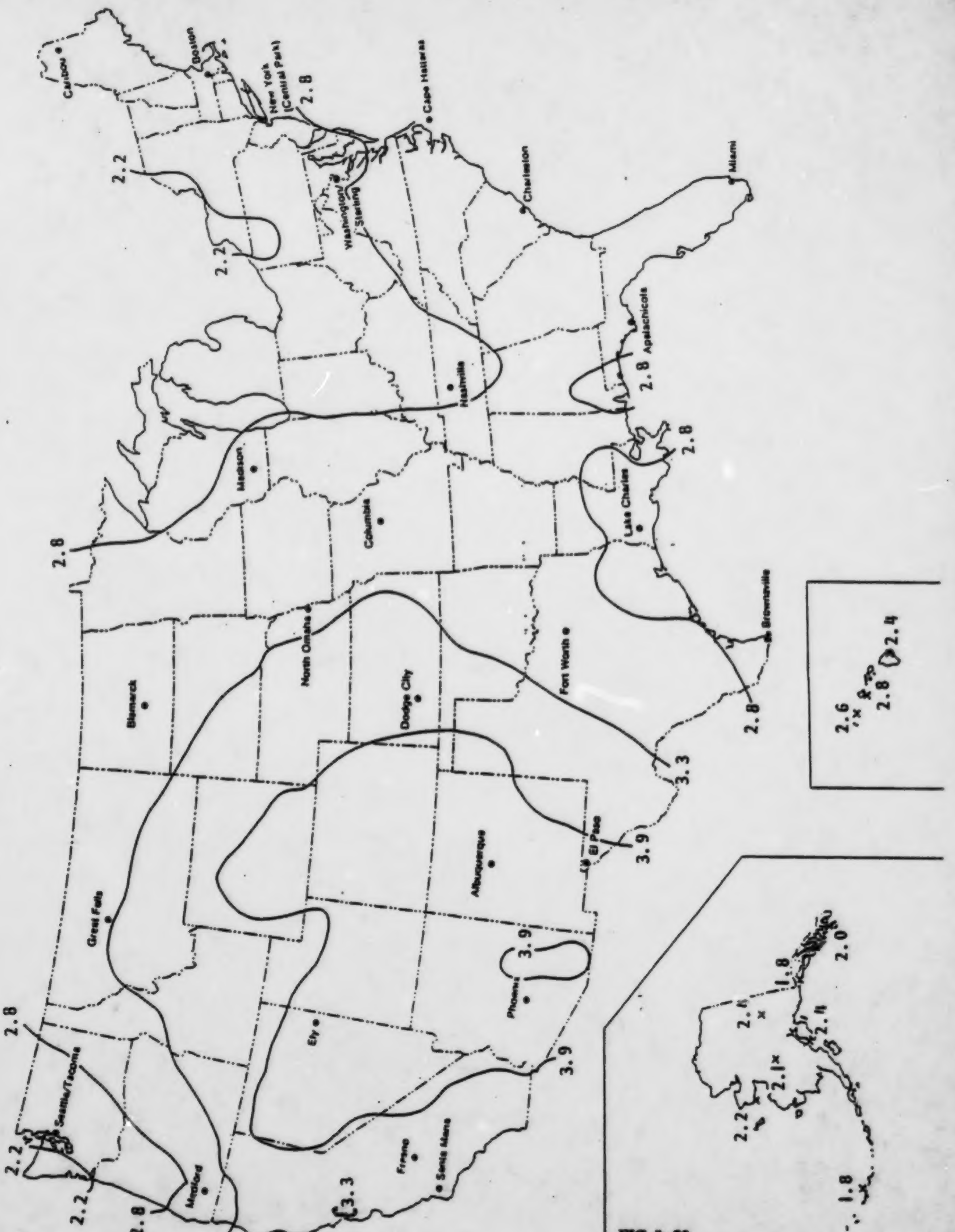


FIG #: S3
SEASON: SPRING/FALL
ANGLE: 90°
UNITS: kWH/m^2/day (= peak sun hours/day)

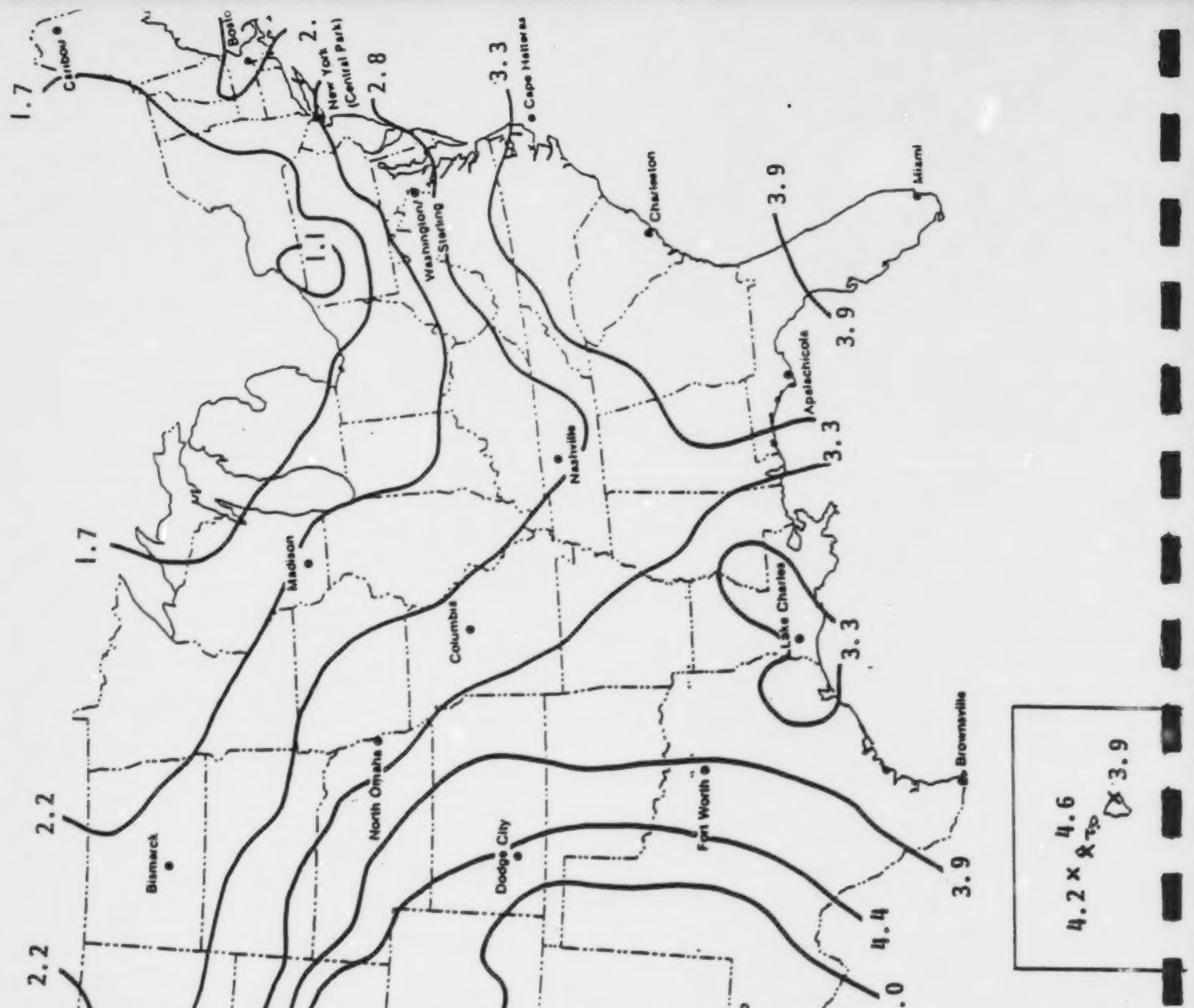


FIG #: S4
SEASON: WINTER
ANGLE: LAT +15°
UNITS: kWH/m²/day (= peak sun hours/day)

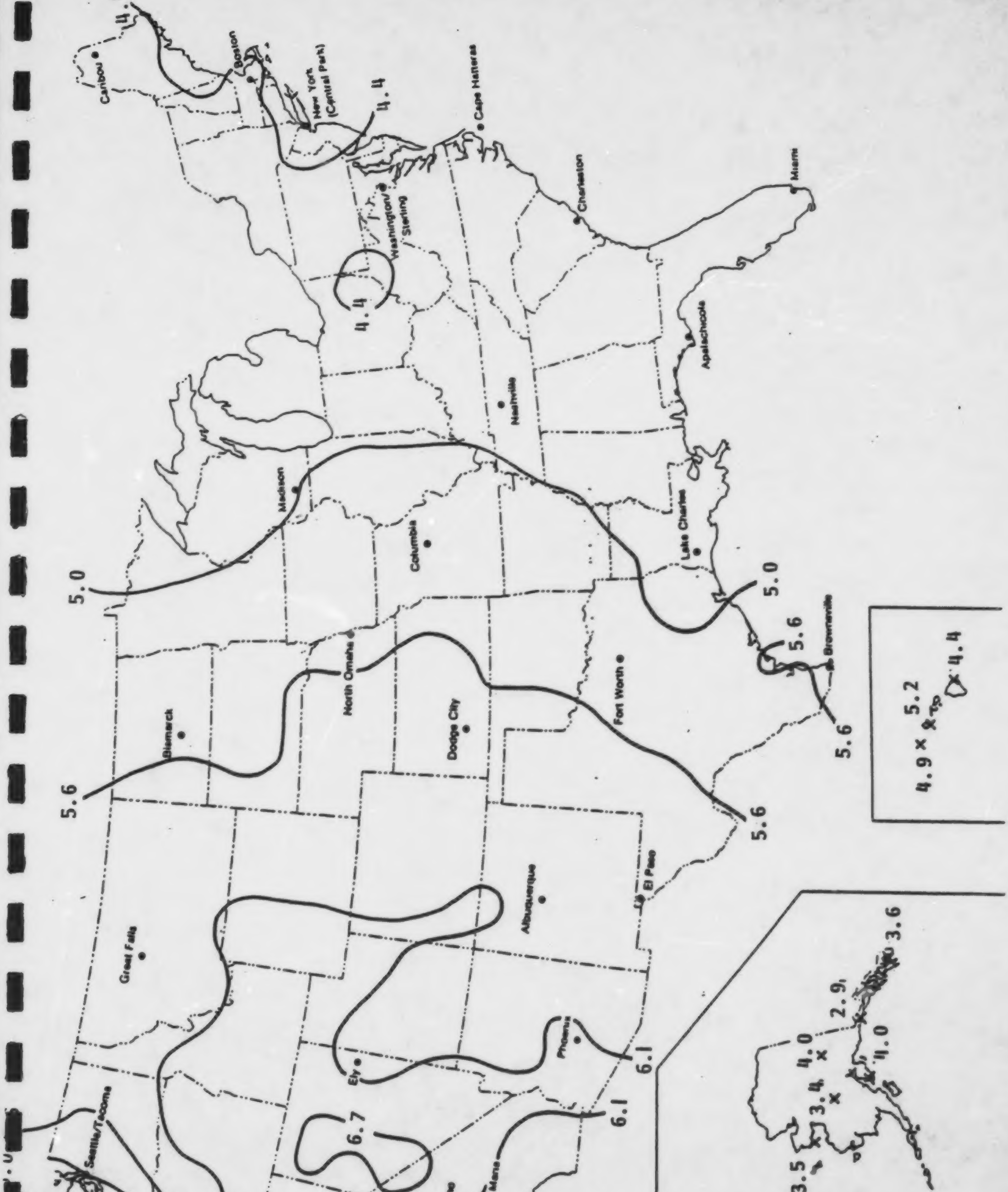


FIG #: S5
SEASON: SUMMER
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/day)

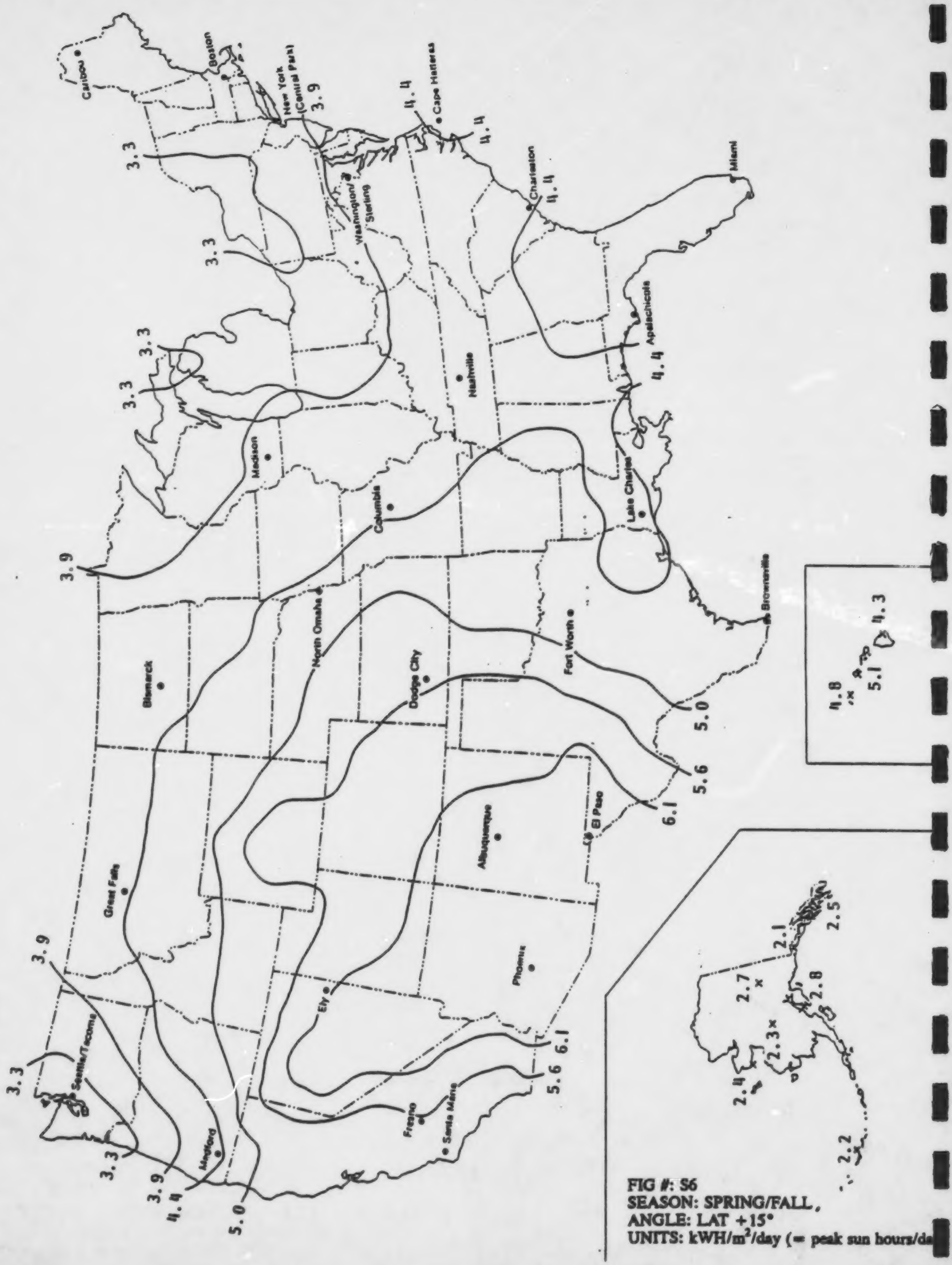


FIG #: S6
SEASON: SPRING/FALL,
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/da

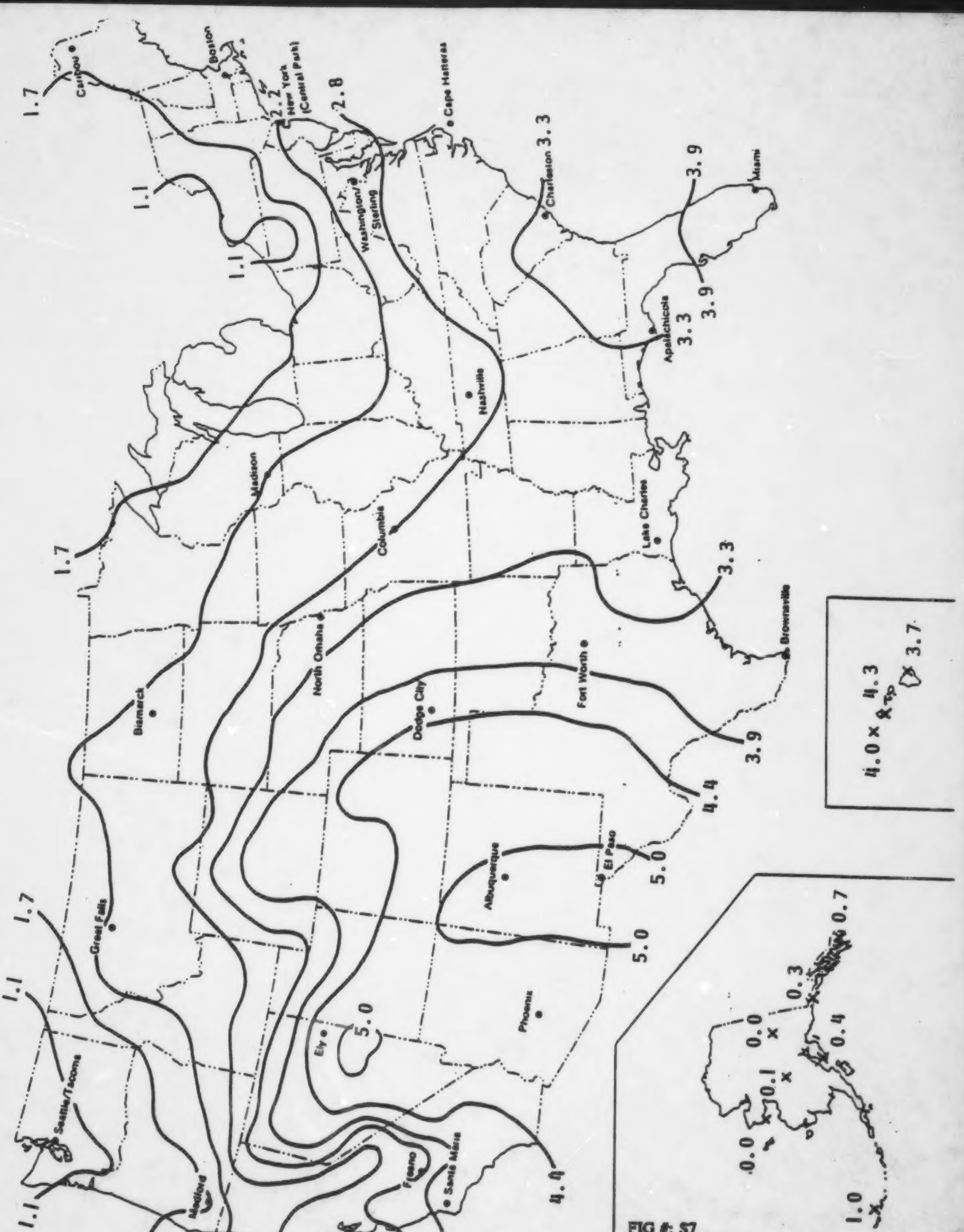


FIG #: S7
SEASON: WINTER
ANGLE: LAT
UNITS: kWH/m^2/day (= peak sun hours/day)

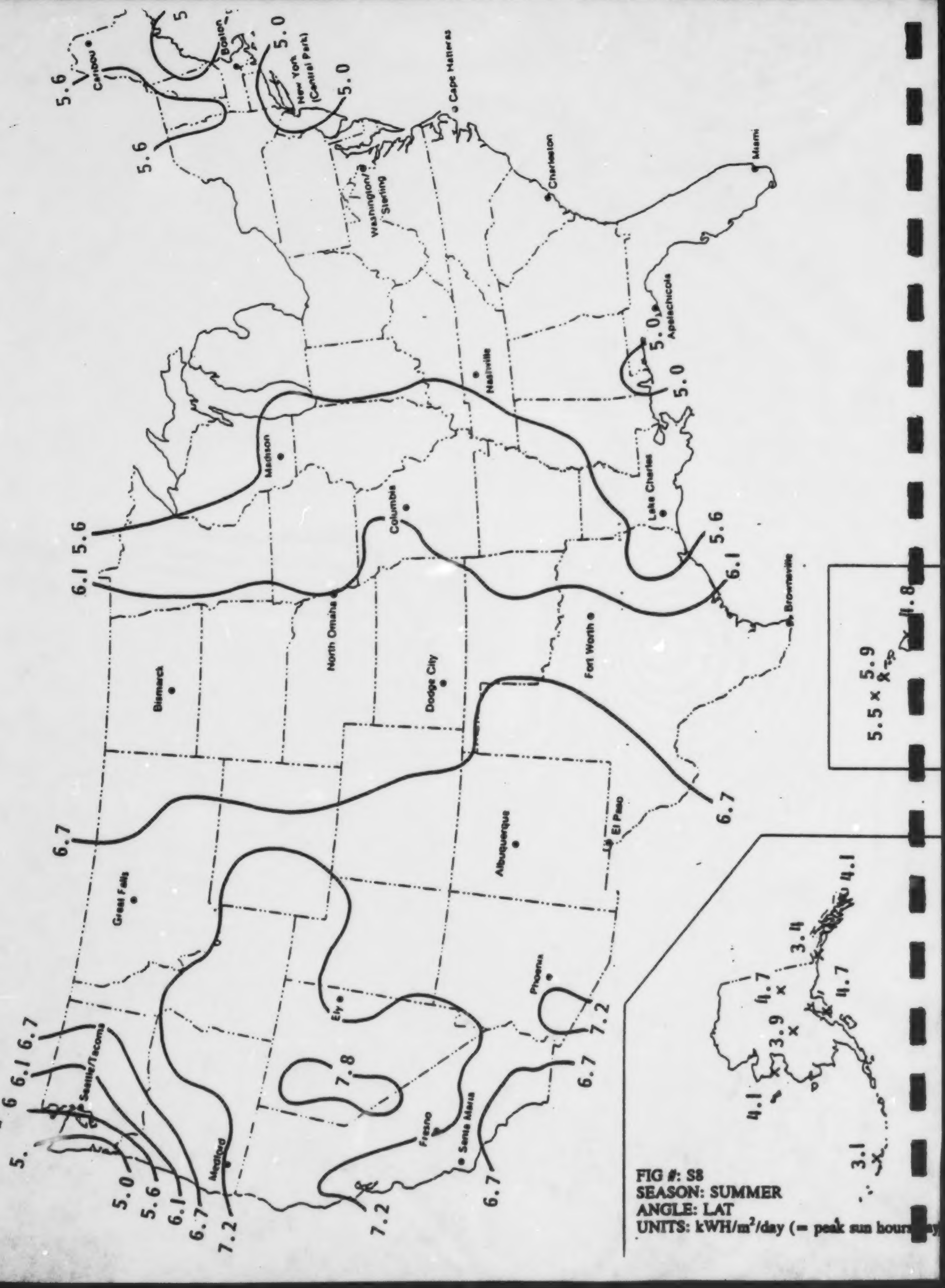


FIG #: S8
SEASON: SUMMER
ANGLE: LAT
UNITS: kWH/m²/day (= peak sun hours/day

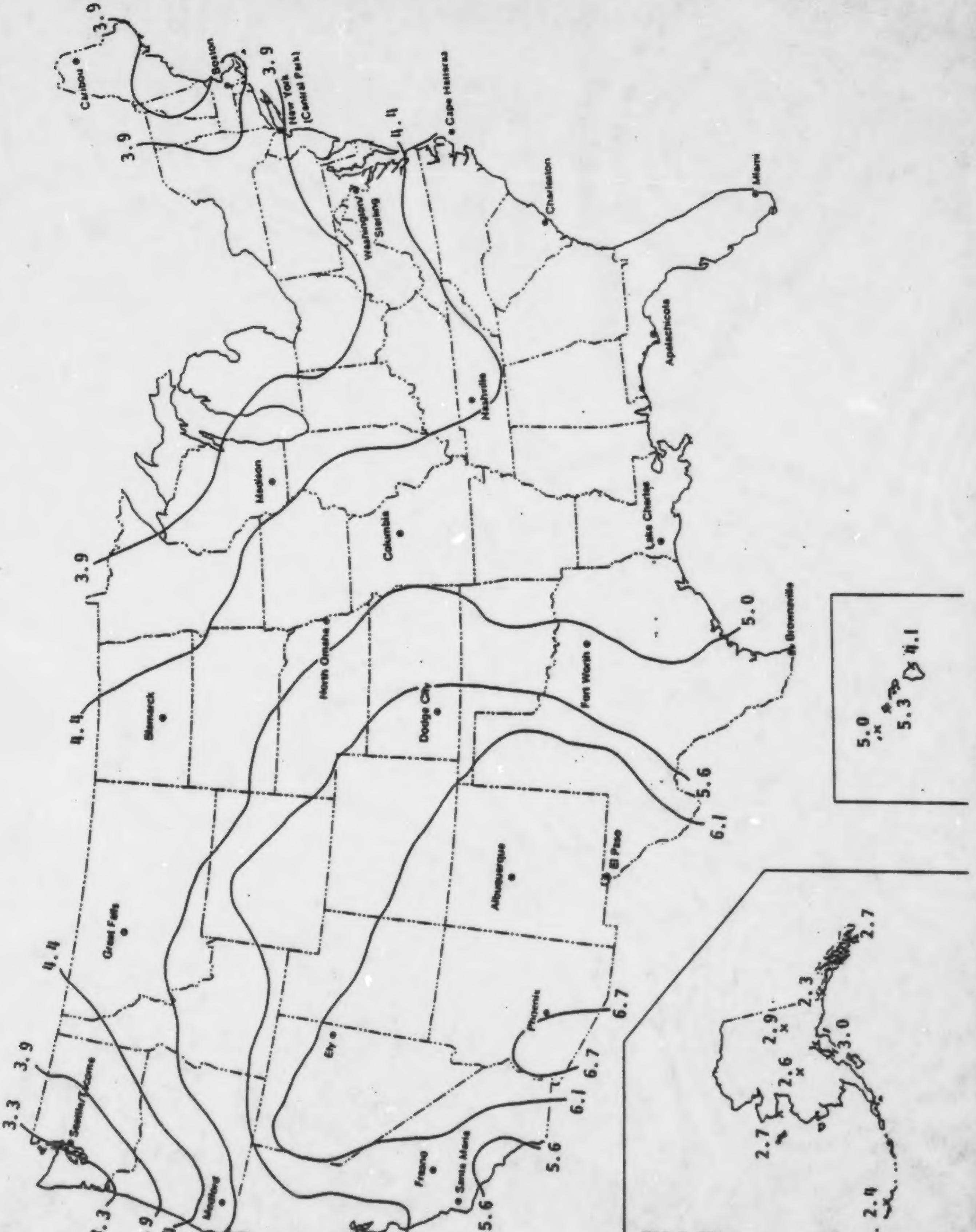


FIG #: S9
SEASON: SPRING/FALL
ANGLE: LAT
UNITS: kWH/m²/day (= peak sun hours/day)

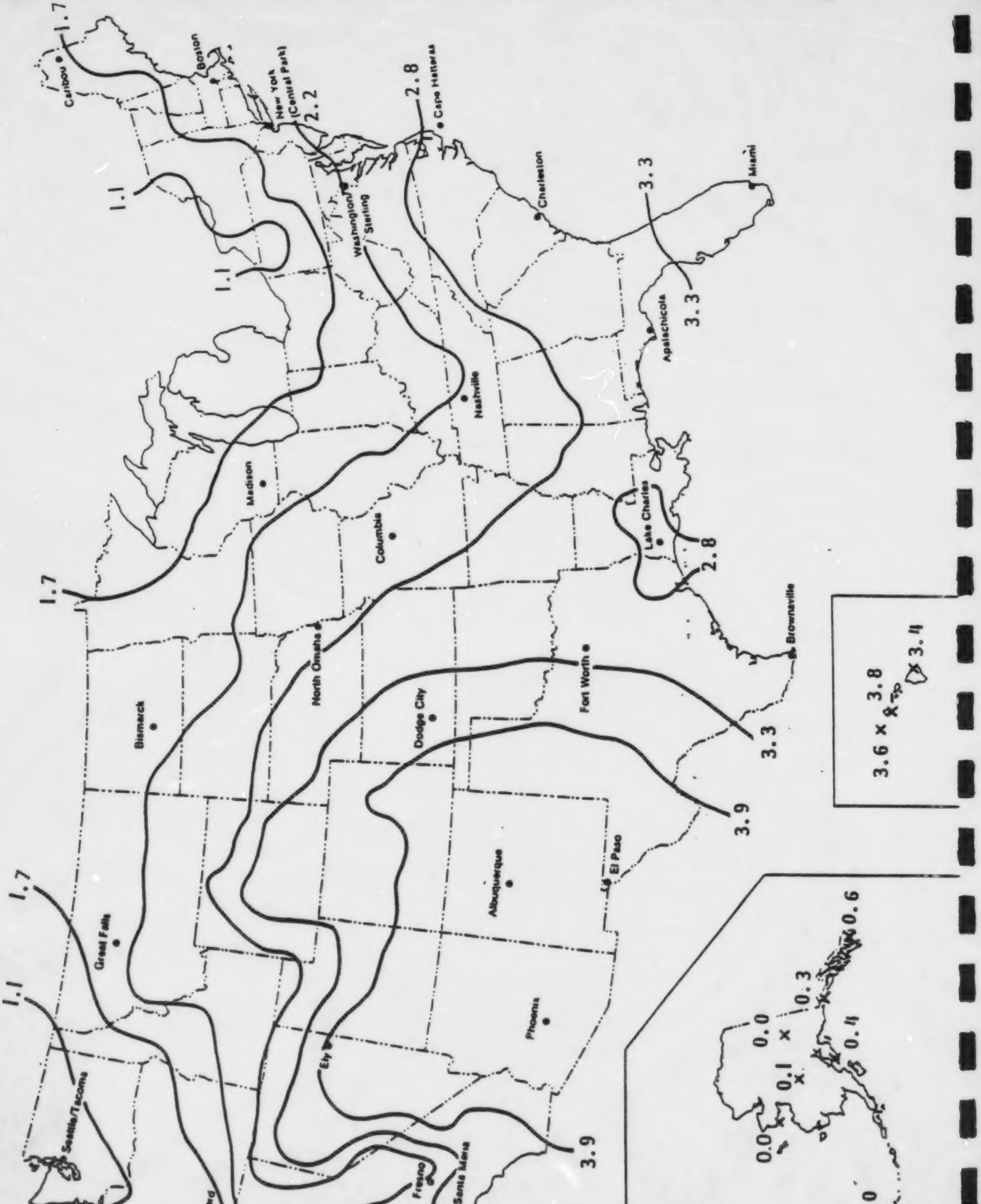


FIG #: S10
SEASON: WINTER
ANGLE: LAT -15°
UNITS: kWH/m²/day (= peak sun hours/day)

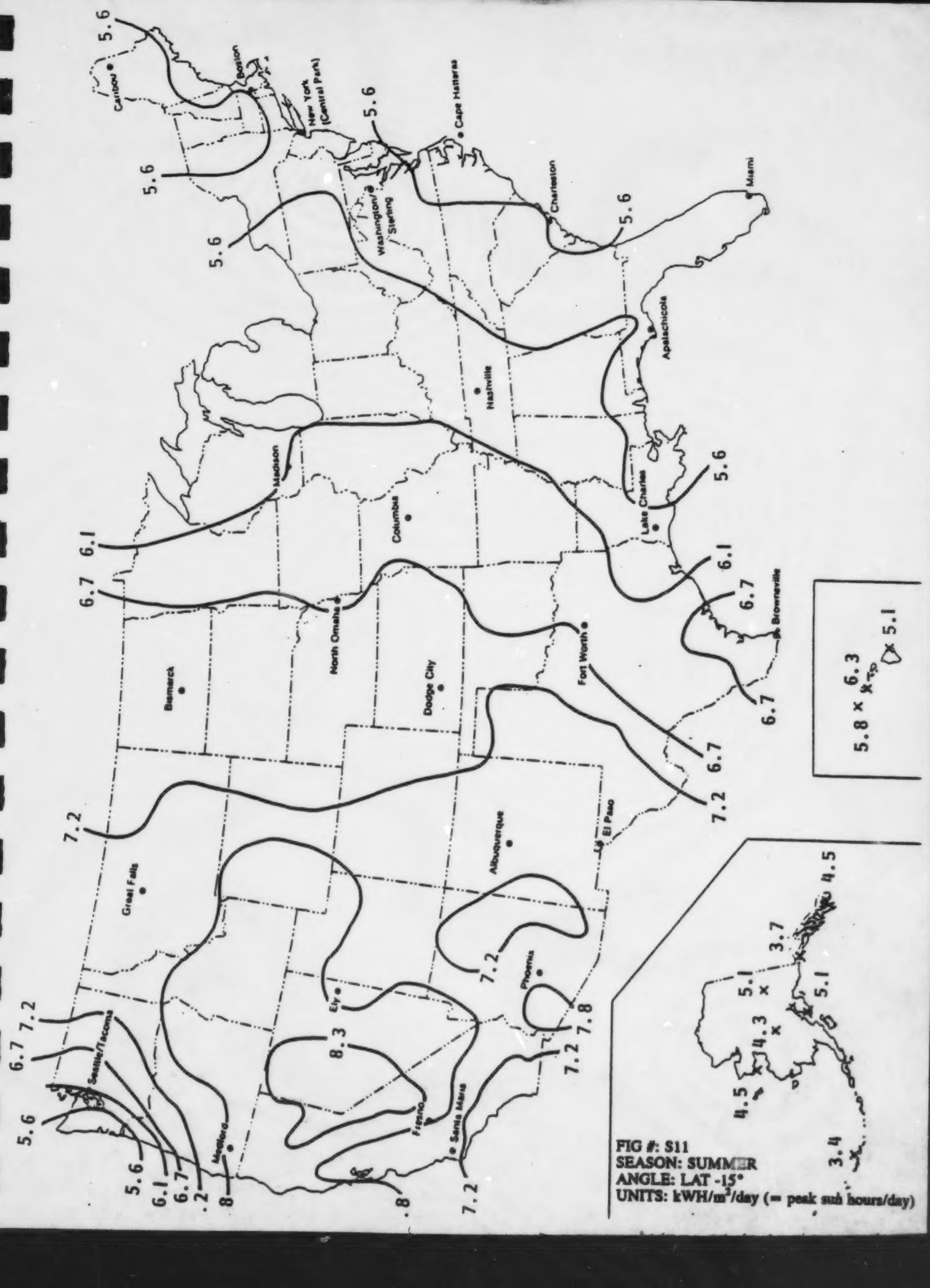


FIG #: S11
SEASON: SUMMER
ANGLE: LAT -15°
UNITS: kWH/m²/day (= peak sun hours/day)

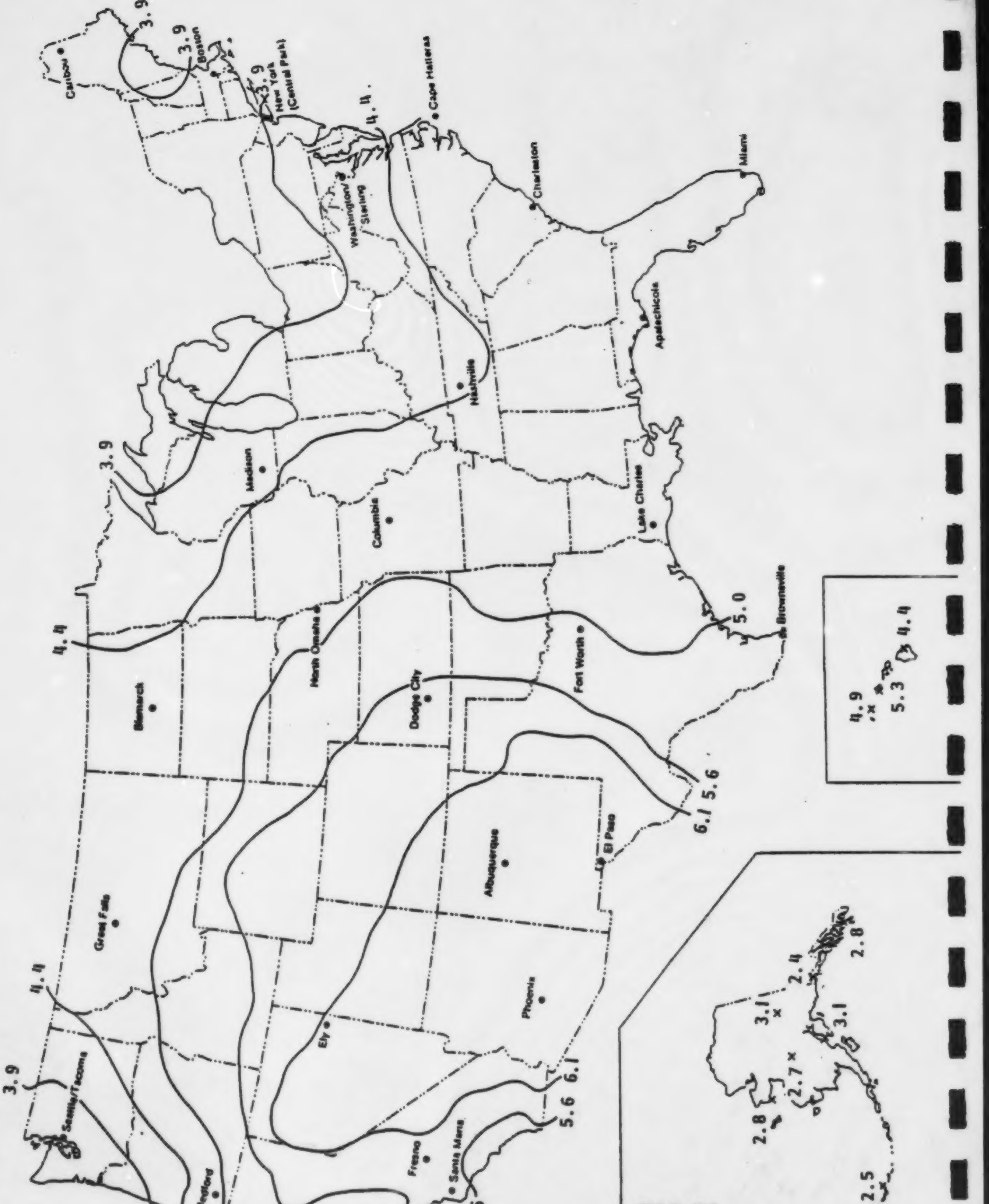


FIG #: S12
SEASON: SPRING/FALL
ANGLE: LAT -15°
UNITS: kWH/m²/day (= peak sun hours/day)

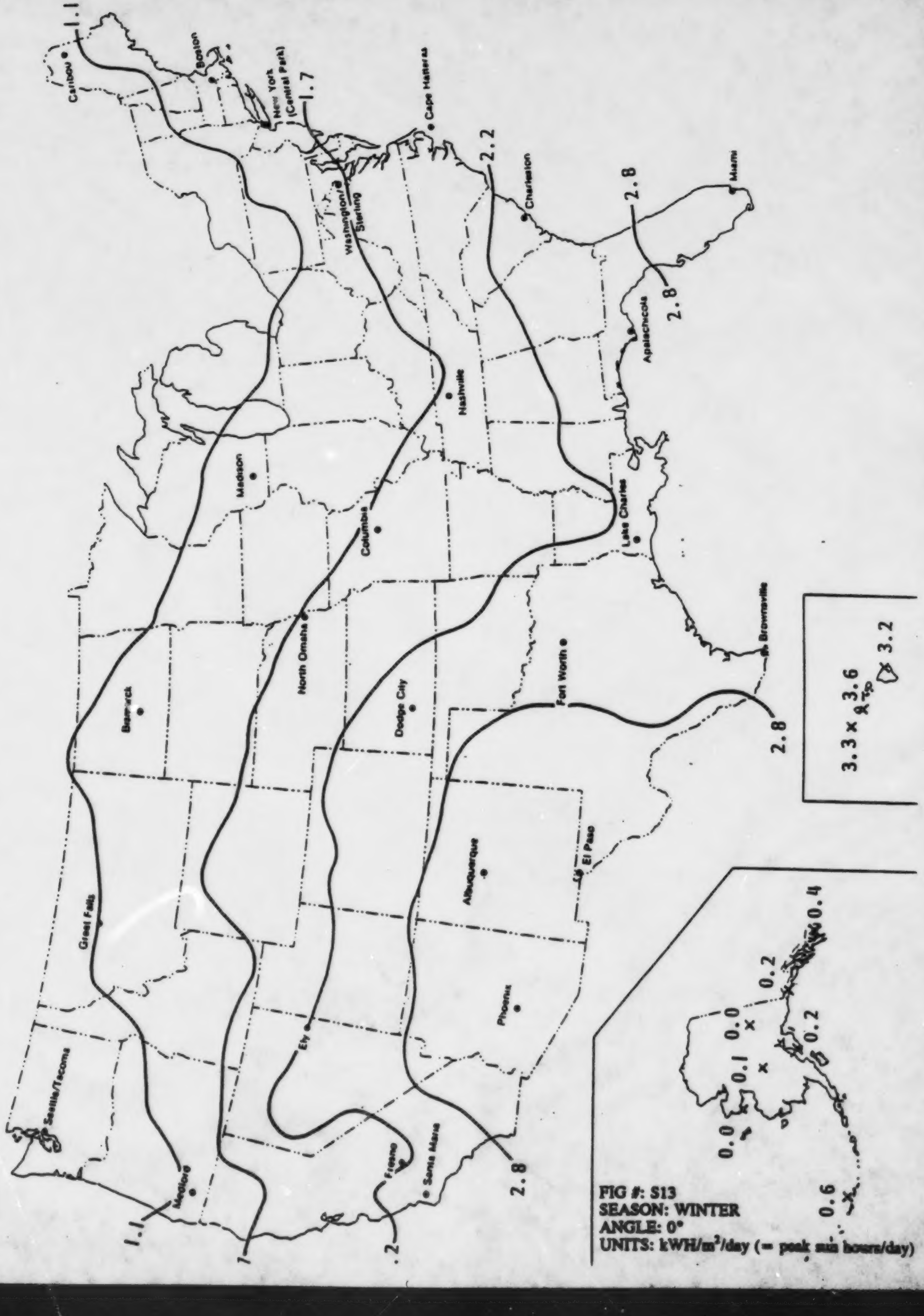


FIG #: S13
SEASON: WINTER
ANGLE: 0°
UNITS: kWH/m^2/day (= peak sun hours/day)

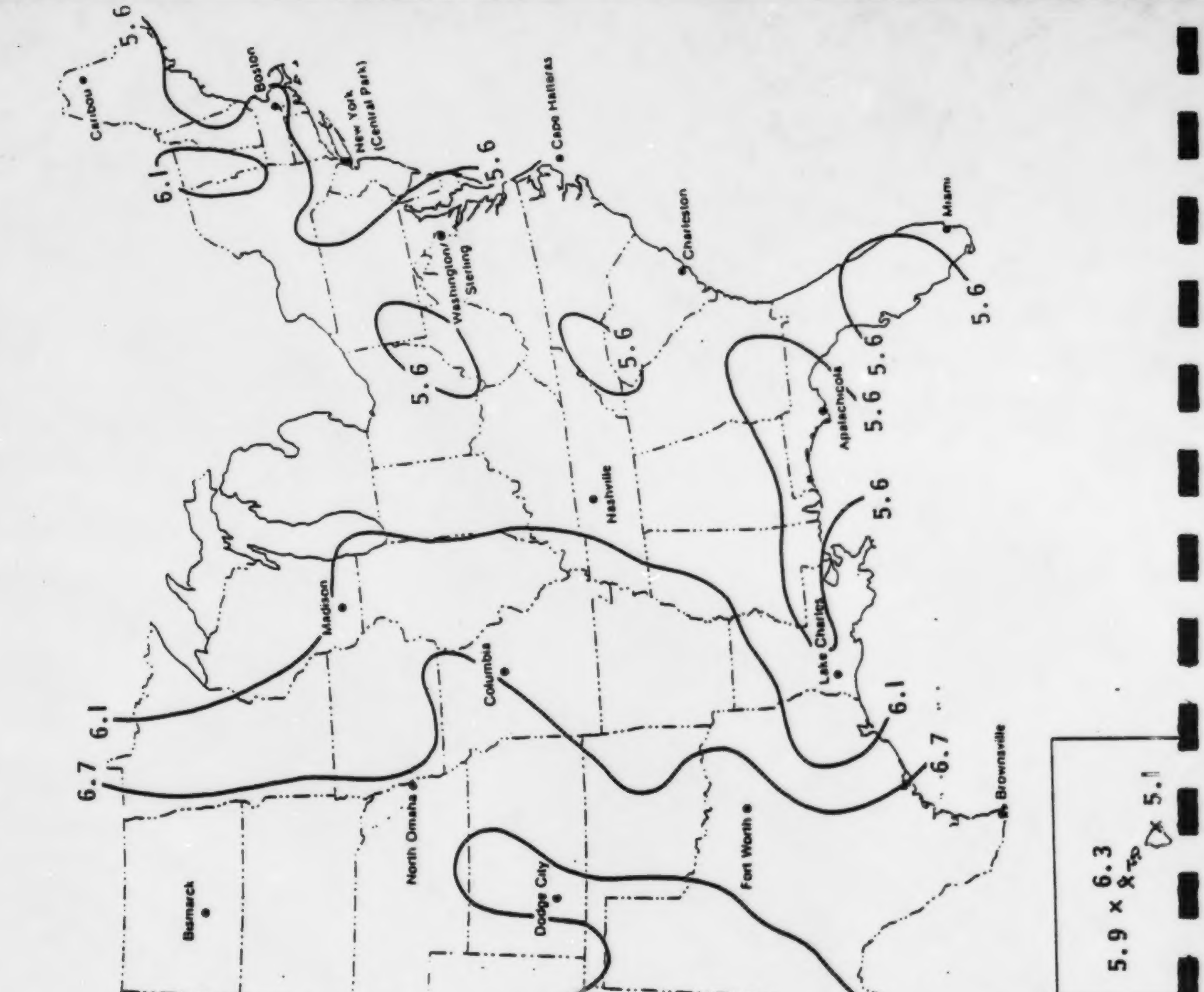


FIG #: S14
SEASON: SUMMER
ANGLE: 0°
UNITS: kWH/m²/day (= peak sun hours/day)

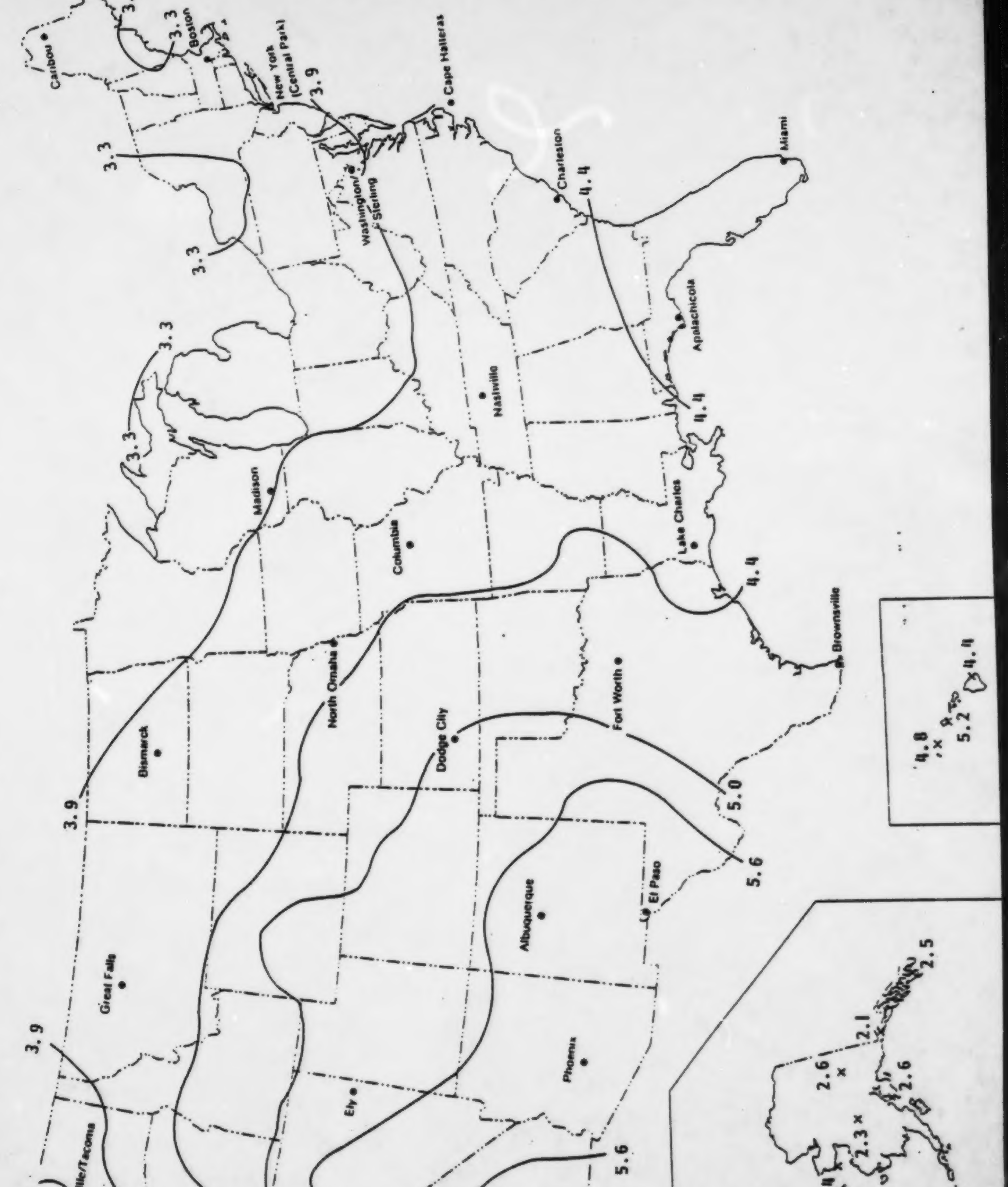


FIG #: S15
SEASON: SPRING/FALL
ANGLE: 0°
UNITS: kWH/m²/day (= peak sun hours/day)

CANADIAN SUNLIGHT
RESOURCE CONTOUR MAPS

Sunlight Availability vs. Month vs. Collector Tilt Angle

Map Data

- origin: Solar Radiation Data Analyses for Canada 1967-1976 (Volume 6)
- published by: Canadian Government Publishing Centre
- units: MJ/m^2/day (÷3.6 to convert to peak sun hours/day)
- tilt angle is measured up from horizontal (0°)

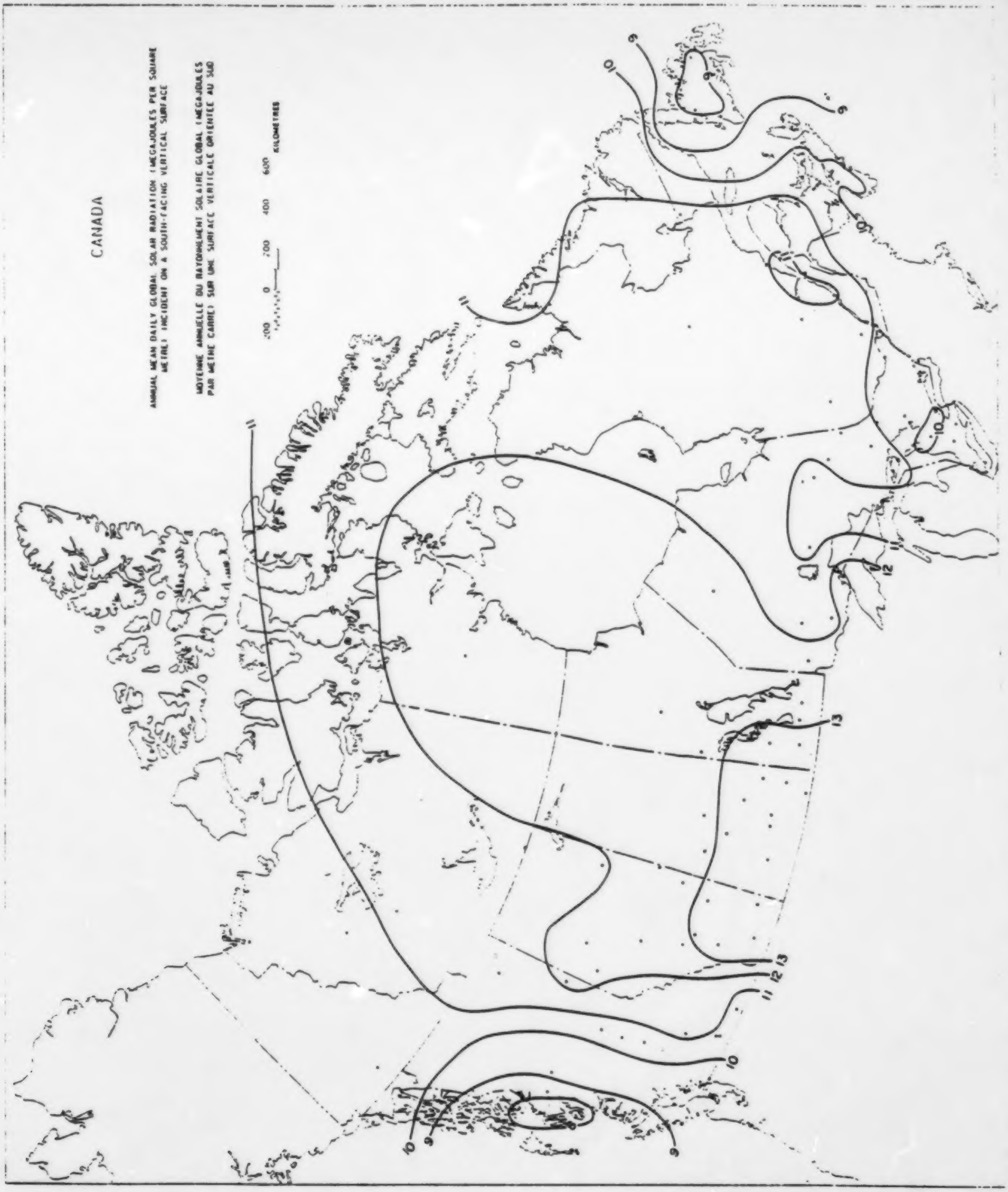

CANADA
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
MOYENNE ANNUELLE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
200 0 200 400 600 KILOMETRES
9
10
11
12
13

FIG #: S16
MONTH: ANNUAL AVERAGE
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

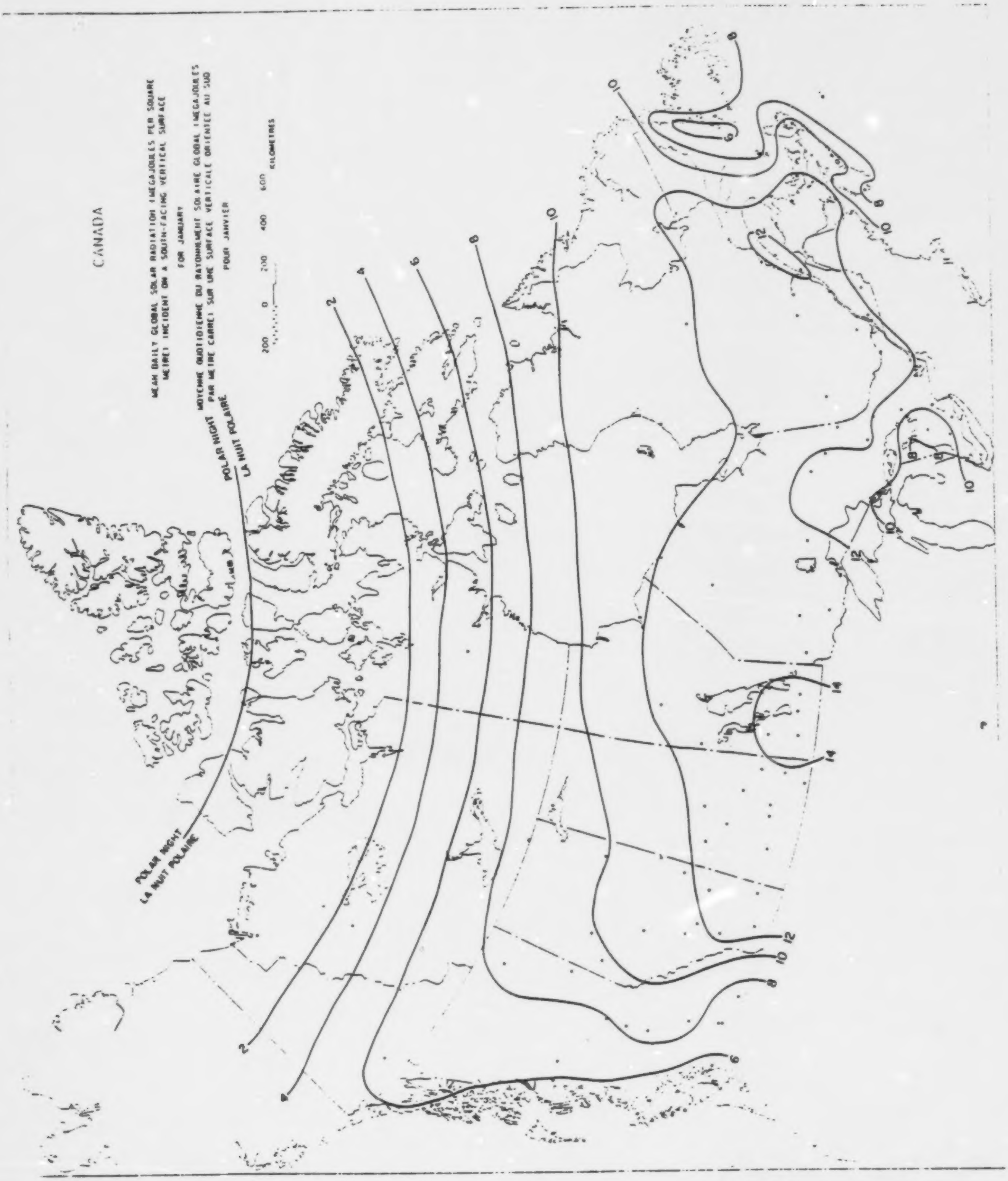

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR JANUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR JANVIER
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10
12
14
2
4
6
8
10
12
14
8
10
12
10
8
6
10
8

FIG #: S17
MONTH: JANUARY
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

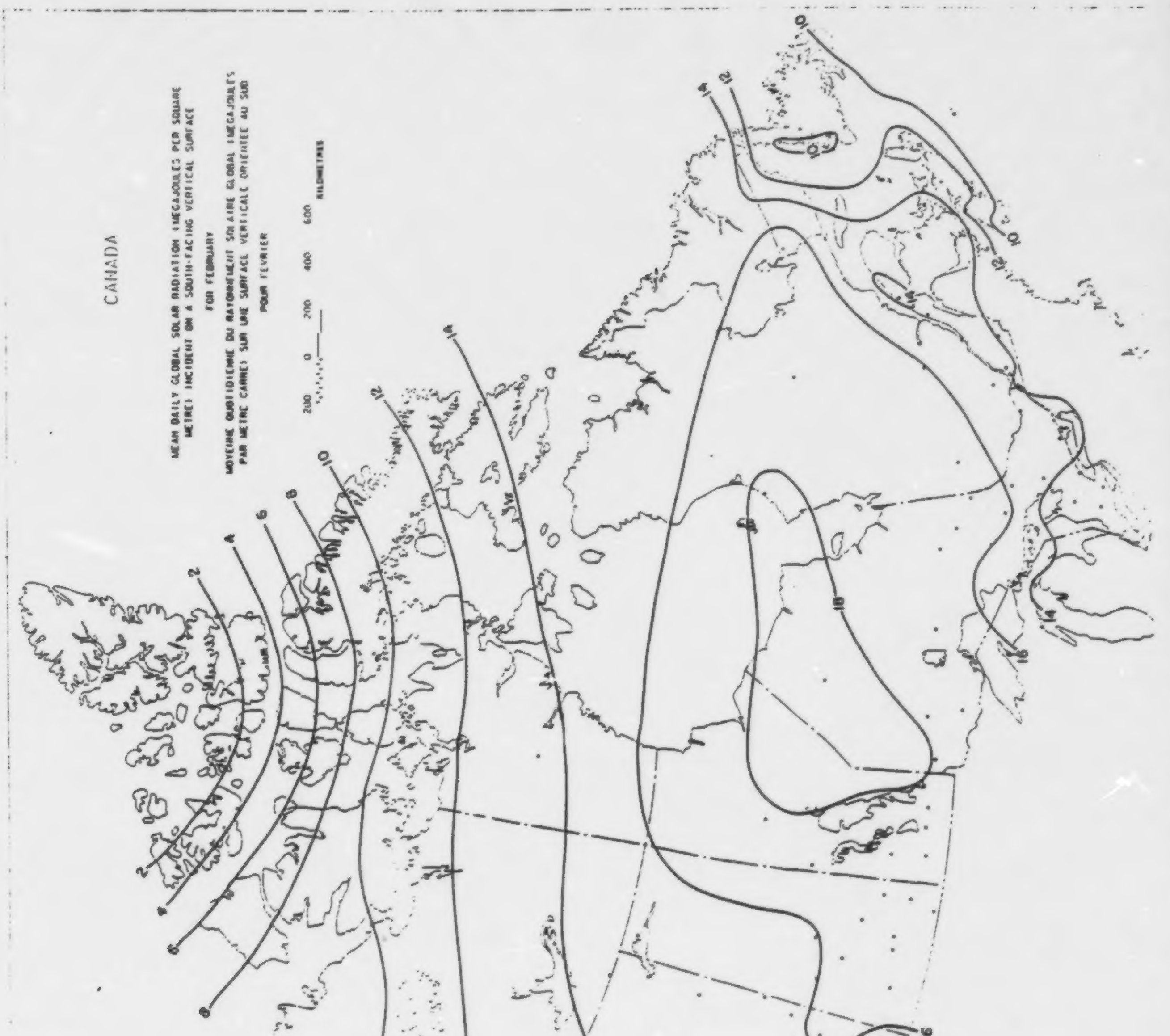

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR FEBRUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR FEVRIER
200 0 200 400 600
KILOMETRES
2
4
6
8
10
12
14
16
18

FIG #: S18
MONTH: FEBRUARY
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

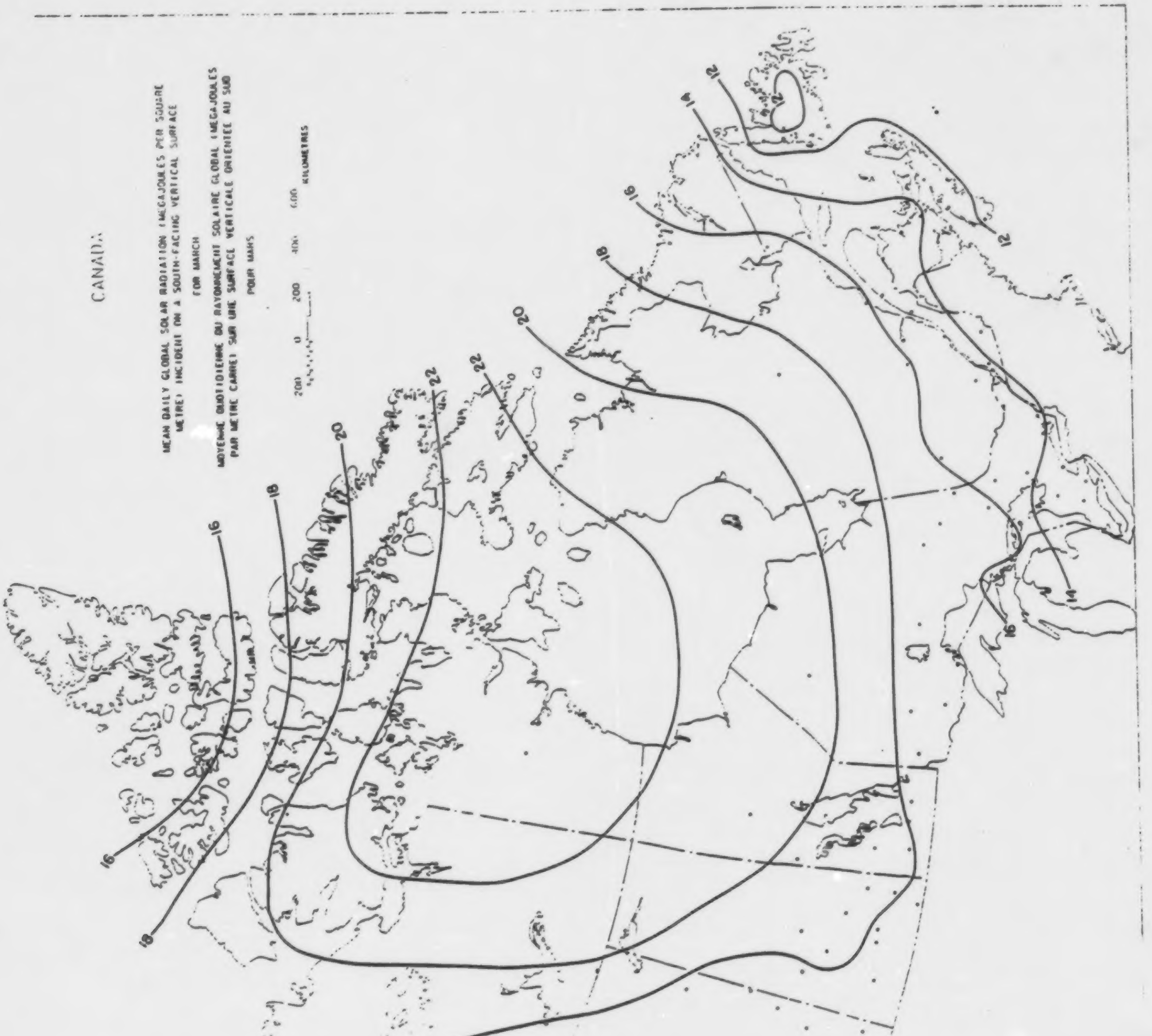

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR MARCH
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR MARS
200 0 200 400 600 KILOMETRES
12
14
16
18
20
22
22
20
18
16
16
18
18
16
14
12
10
10
14
12
14
16
12

FIG #: 519
MONTH: MARCH
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

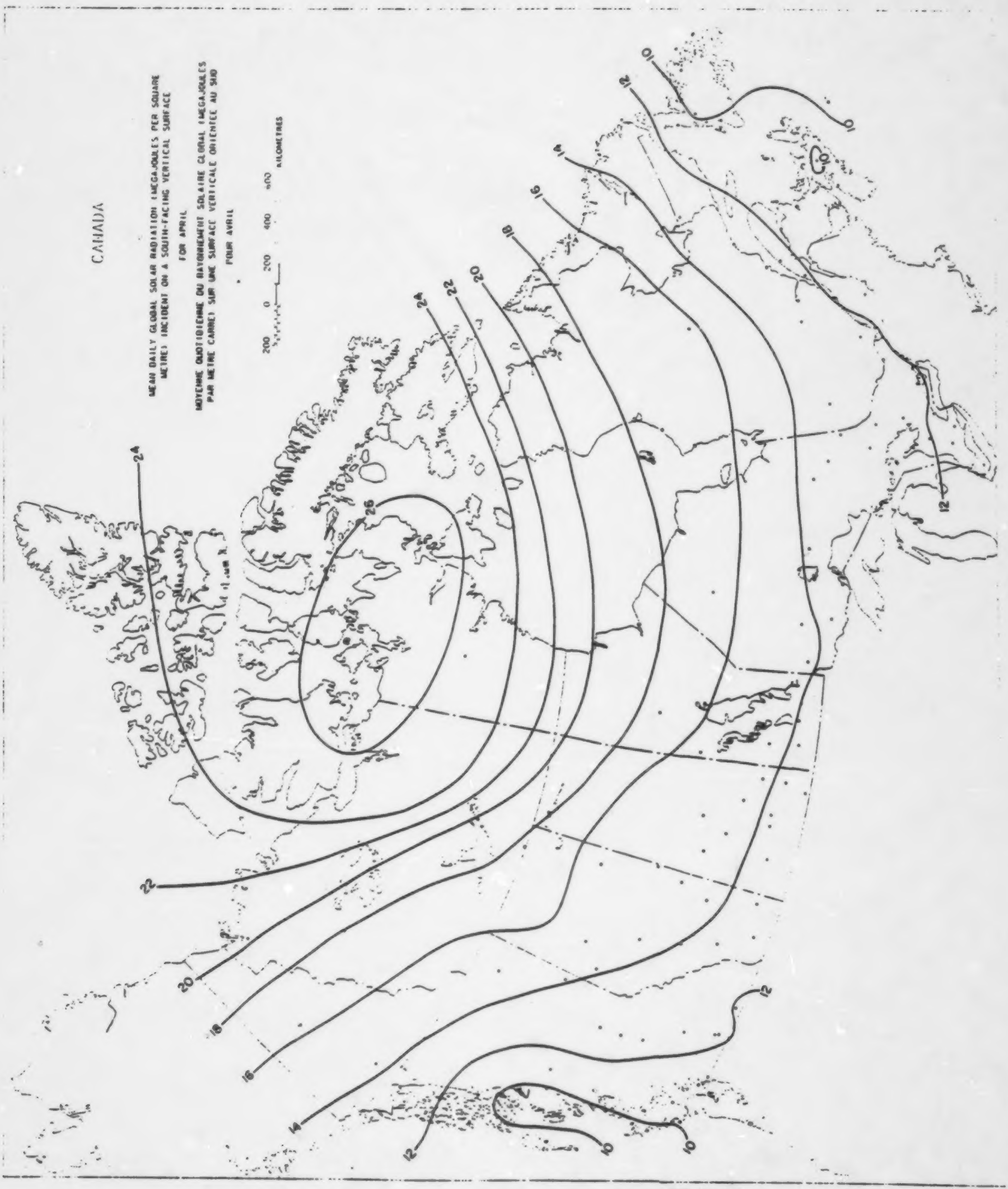

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR APRIL
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR AVRIL
200 0 200 400 600 KILOMETRES
10
12
14
16
18
20
22
24
26
24
22
20
18
16
14
12
12
10
10
12
10
10

FIG #: S20
MONTH: APRIL
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

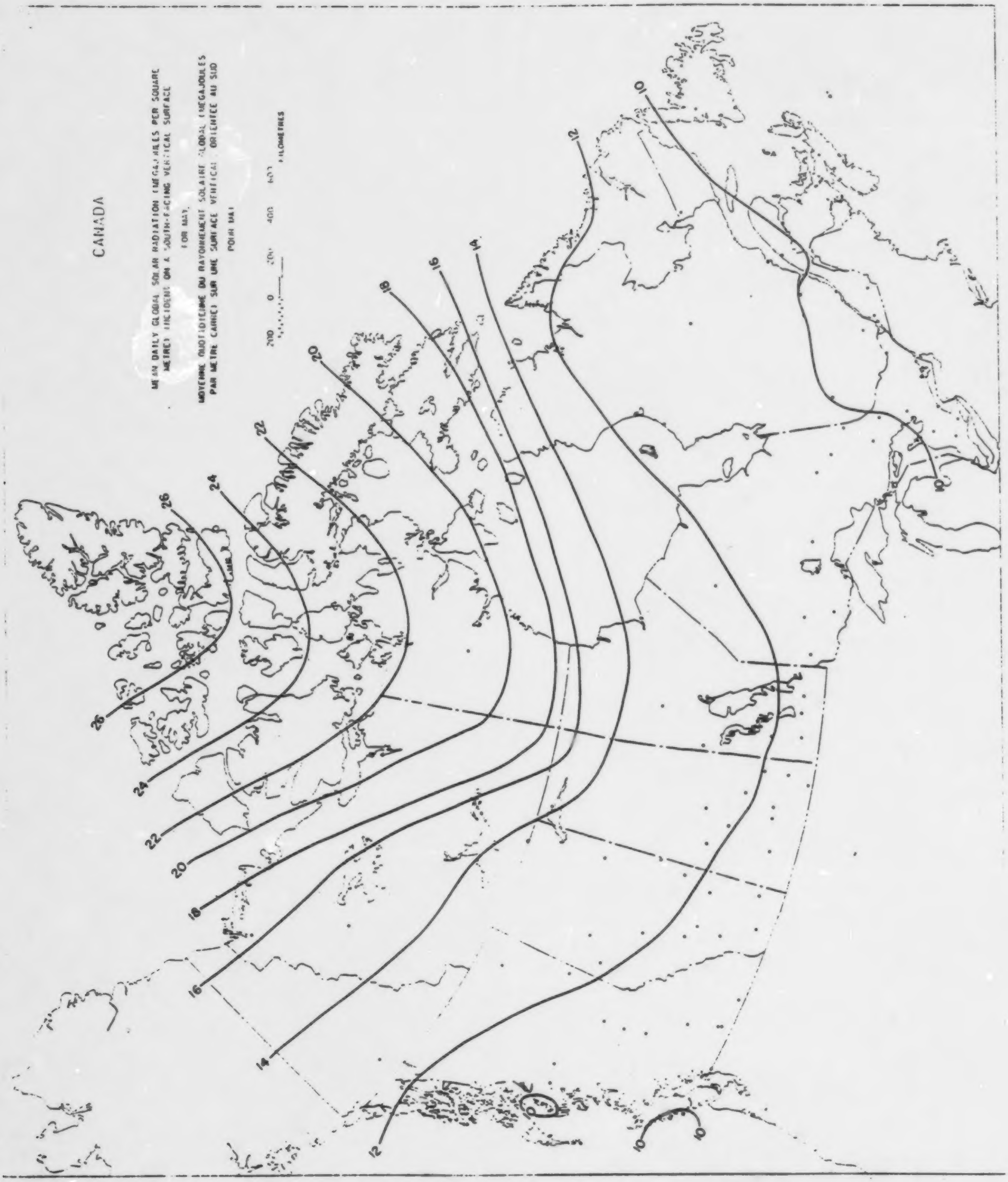
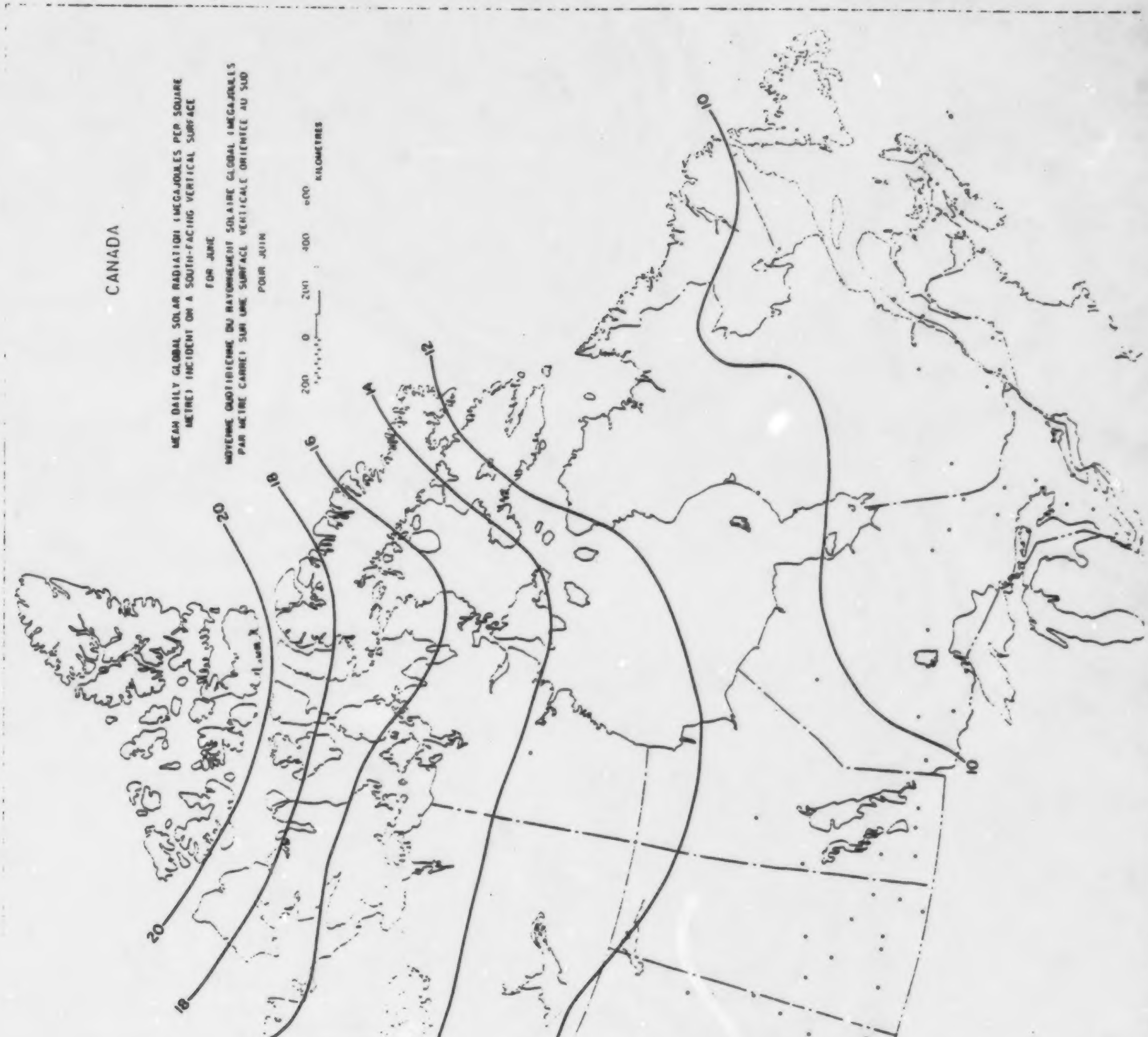

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR MAY.
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR MAI
200 0 200 400 600 KILOMETRES
26
26
24
24
22
22
20
20
18
18
16
16
14
14
12
12
10
10
10
10

FIG #: S21
MONTH: MAY
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day



CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR JUNE
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR JUIN
200 0 200 400 600 KILOMETRES
10
12
14
16
18
20

FIG #: S22
MONTH: JUNE
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

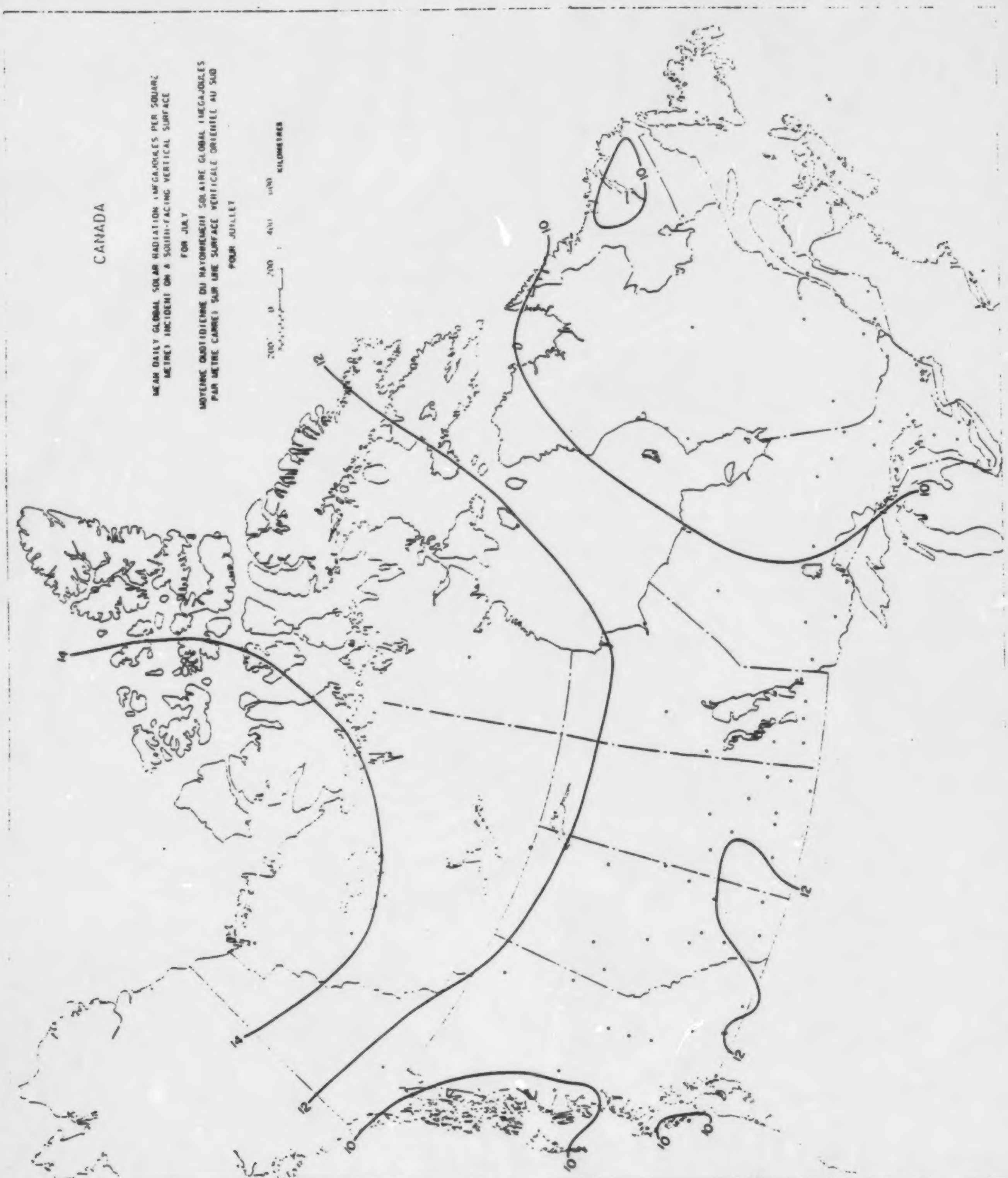

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE
METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR JULY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES
PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR JUILLET
200 0 200 400 600
KILOMETRES
14
14
12
12
12
12
10
10
10
10
10
10
10

FIG #: S23
MONTH: JULY
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

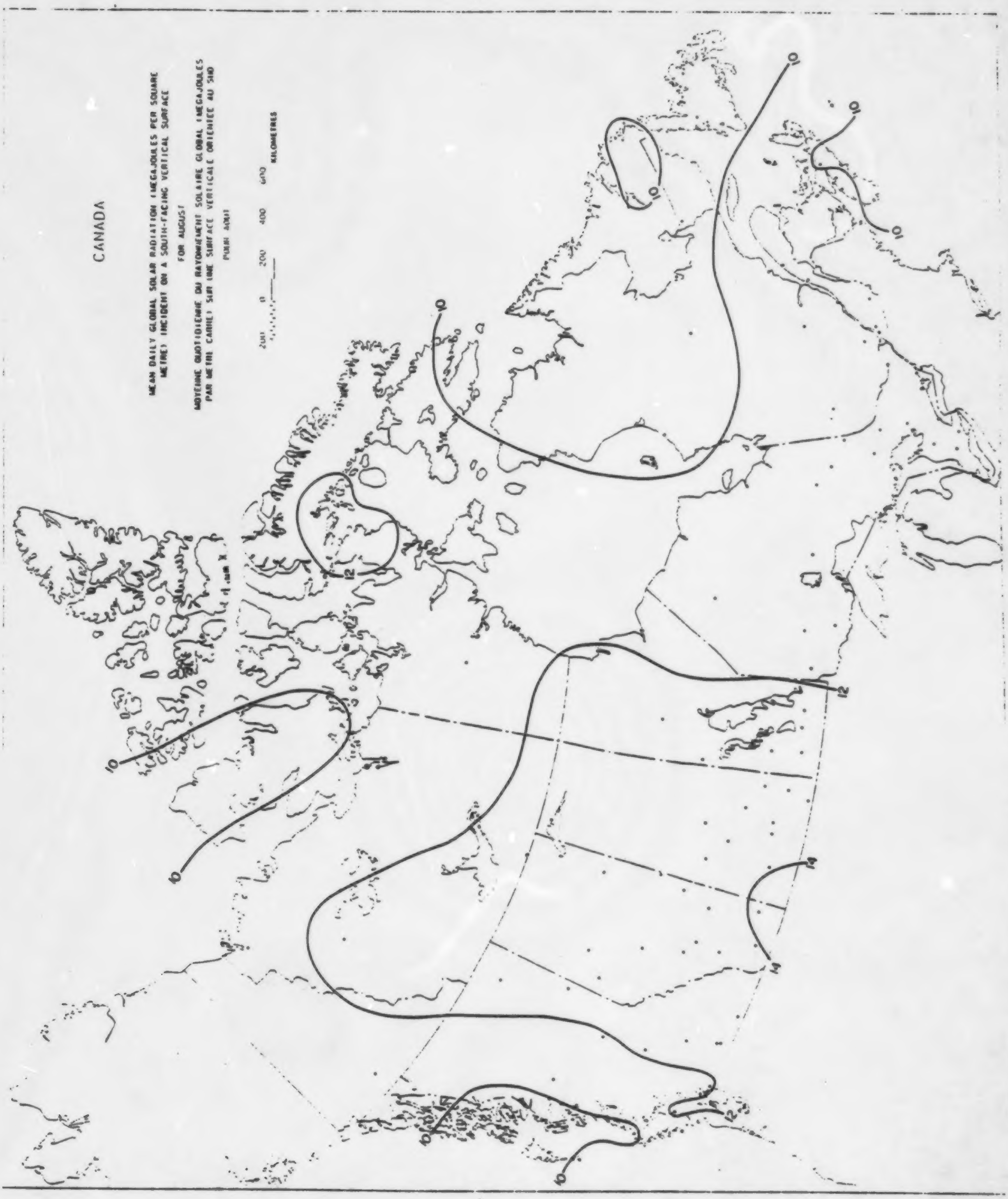

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR AUGUST
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR AOUT
200 0 200 400 600
KILOMETRES
10
10
10
10
10
12
10
10
12
14
14
12
10
10

FIG #: S24
MONTH: AUGUST
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

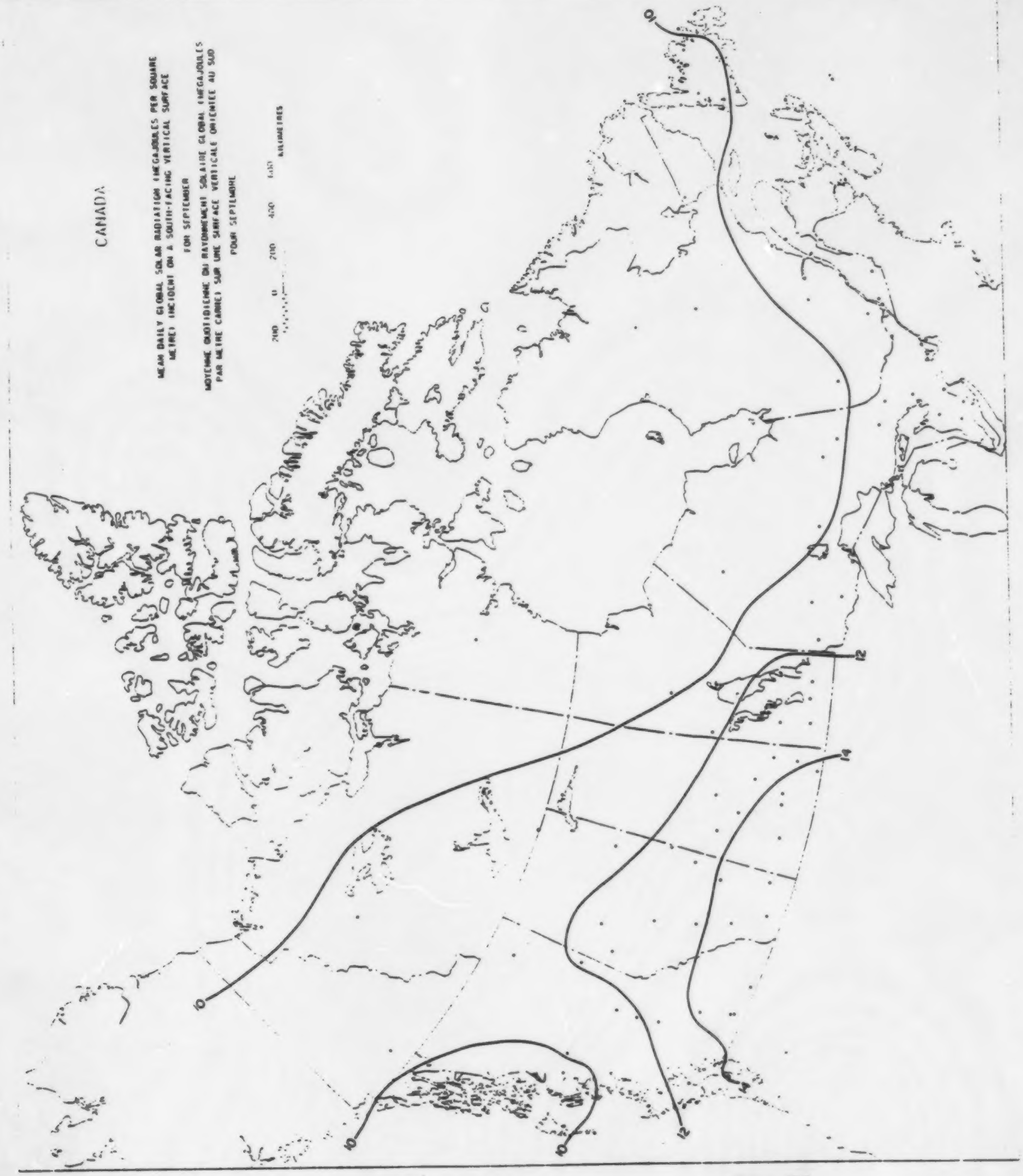

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR SEPTEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR SEPTEMBRE
200 0 200 400 600
KILOMETRES
10
12
14
12
10
10
10

FIG #: S25
MONTH: SEPTEMBER
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

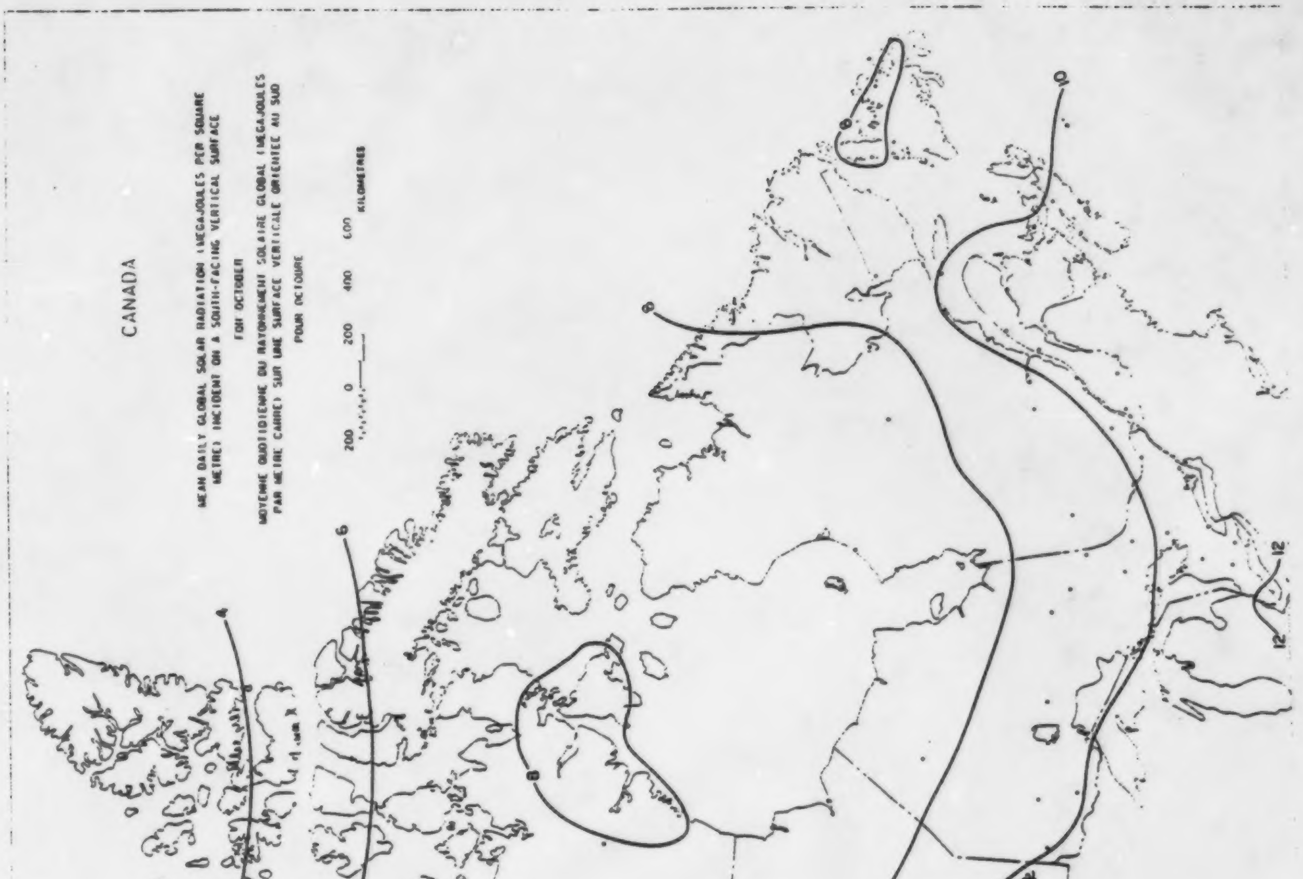

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR OCTOBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR OCTOBRE
200 0 200 400 600 KILOMETRES
4
6
8
10
12
14

FIG #: S26
MONTH: OCTOBER
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

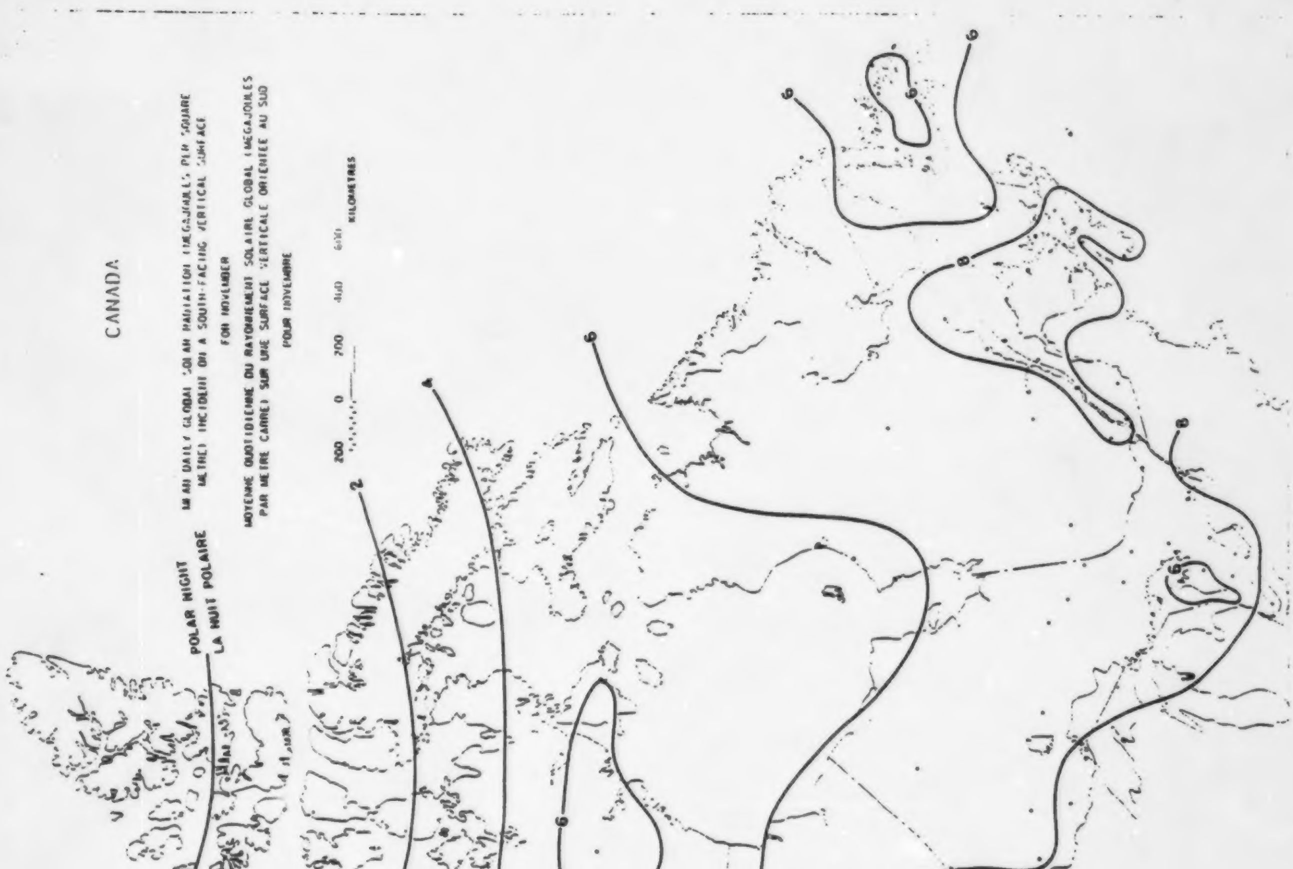

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR NOVEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR NOVEMBRE
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
2
4
4
6
6
6
6
6
6
6
8
8
8
10
10
12
12

FIG #: S27
MONTH: NOVEMBER
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

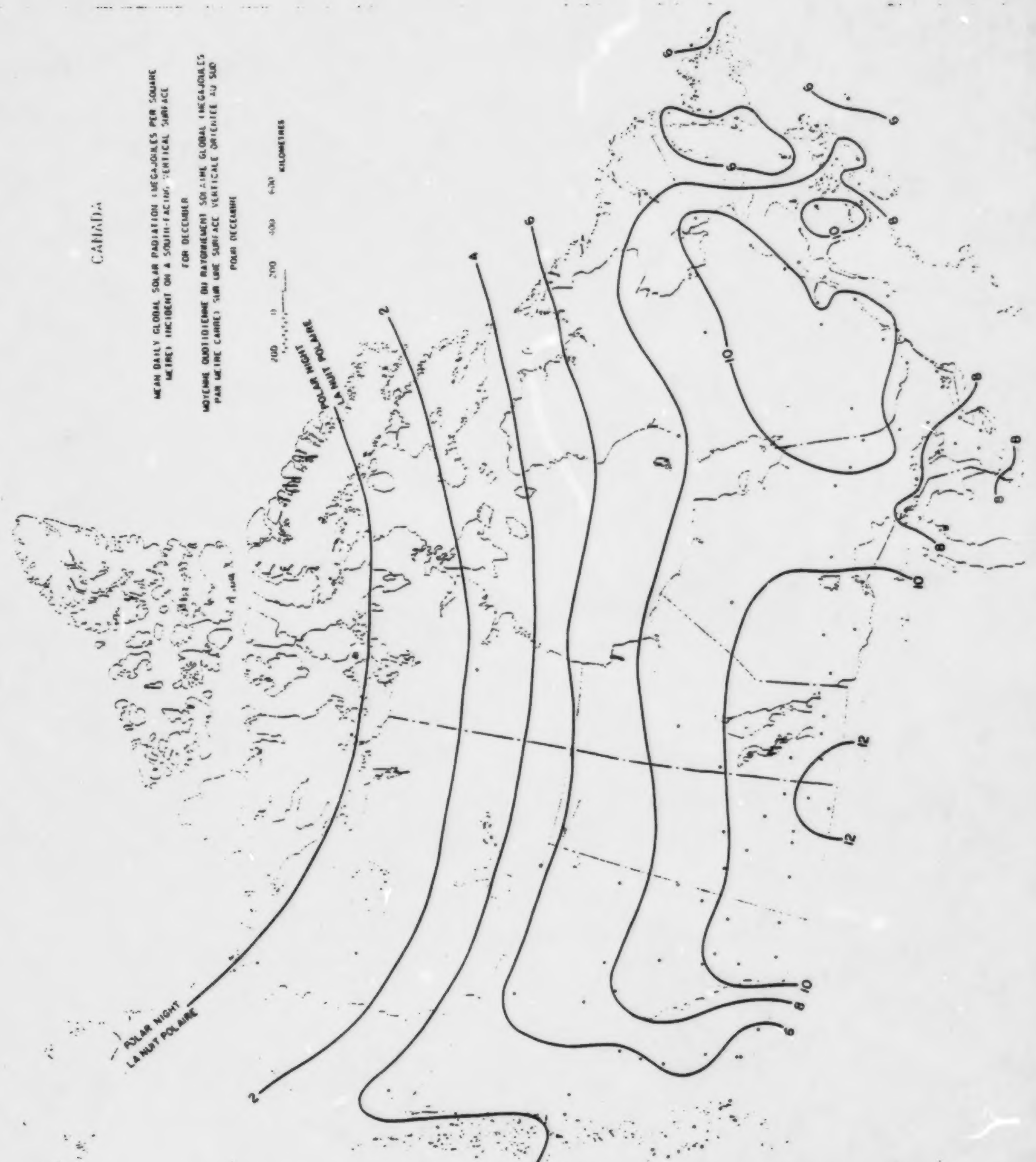

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING VERTICAL SURFACE
FOR DECEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE VERTICALE ORIENTEE AU SUD
POUR DECEMBRE
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10
12

FIG #: S28
MONTH: DECEMBER
ANGLE: 90°
UNITS: ÷3.6 for peak sun hours/day

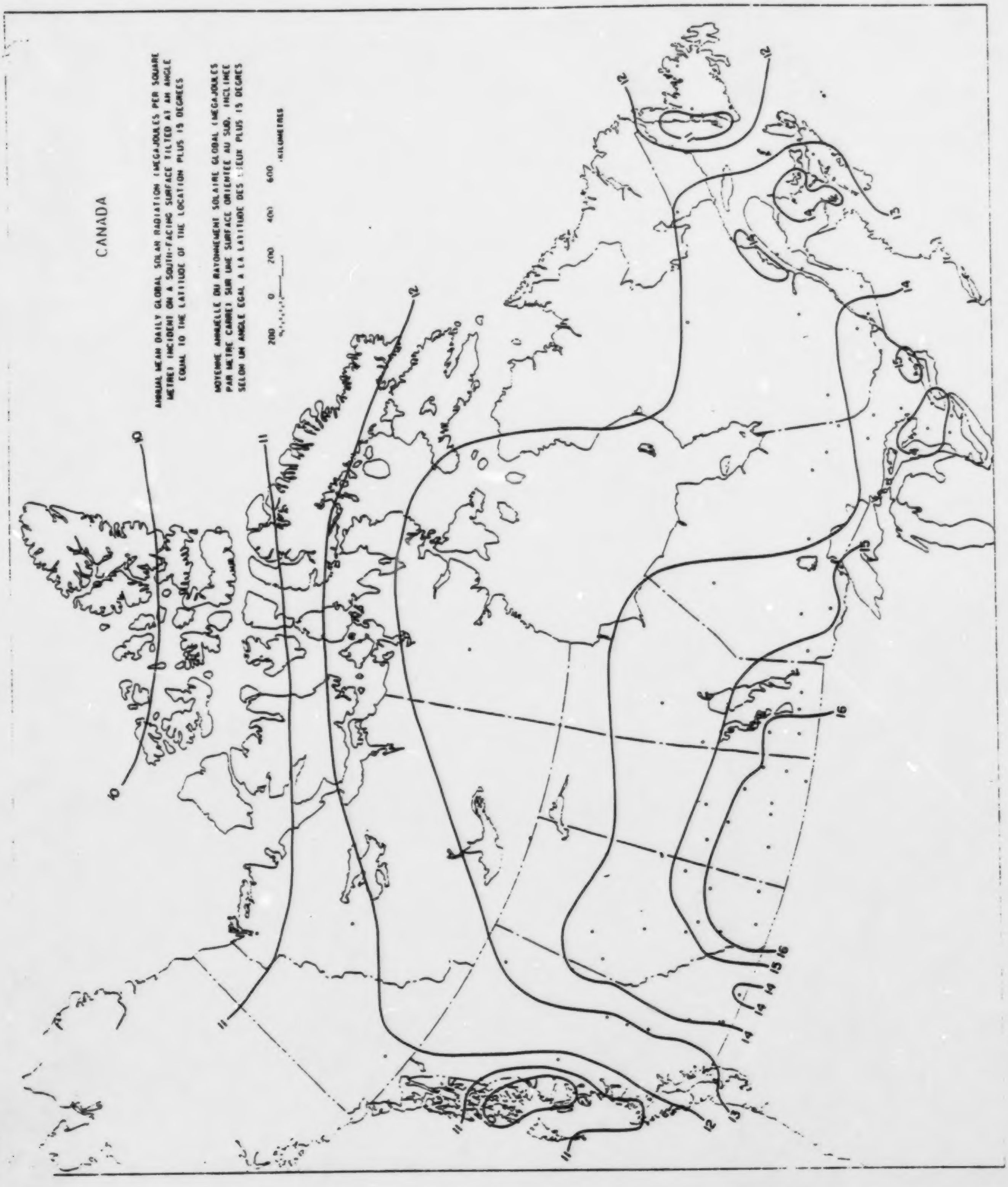

CANADA
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
MOYENNE ANNUELLE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
200 0 200 400 600 KILOMETRES
10
10
11
11
12
12
12
13
13
14
14
14
14
15
15
15
16
16
11
11
12
13

FIG #: S29
MONTH: ANNUAL AVERAGE
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

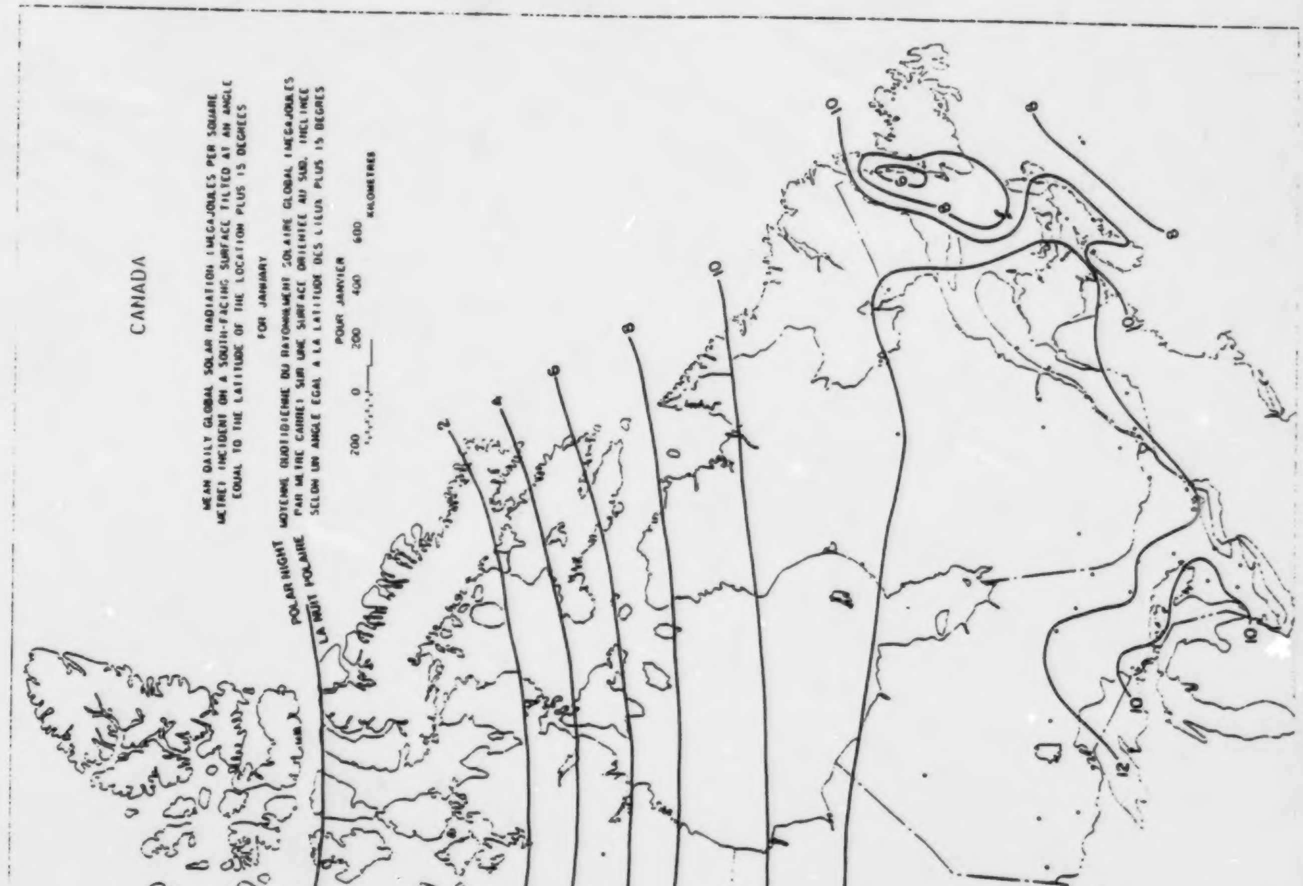

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR JANUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR JANVIER
200 0 200 400 600
KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10
12
14
2
4
6
8
10
12
14
6
8
10
6
6
6

FIG #: S30
MONTH: JANUARY
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

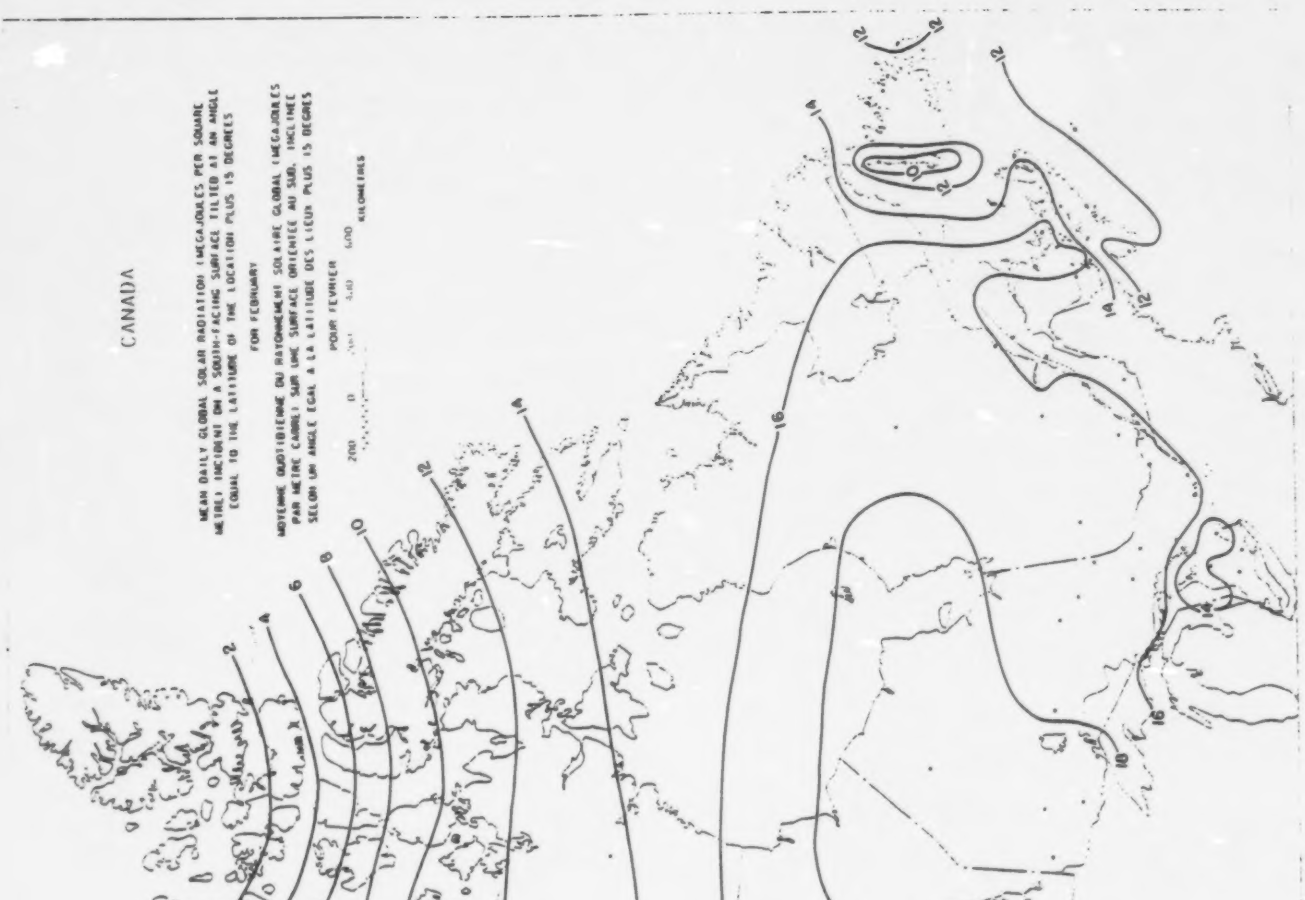

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR FEBRUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR FEVRIER
200 0 200 400 600
KILOMETRES
2
4
6
8
10
12
14
16
18

FIG #: S31
MONTH: FEBRUARY
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

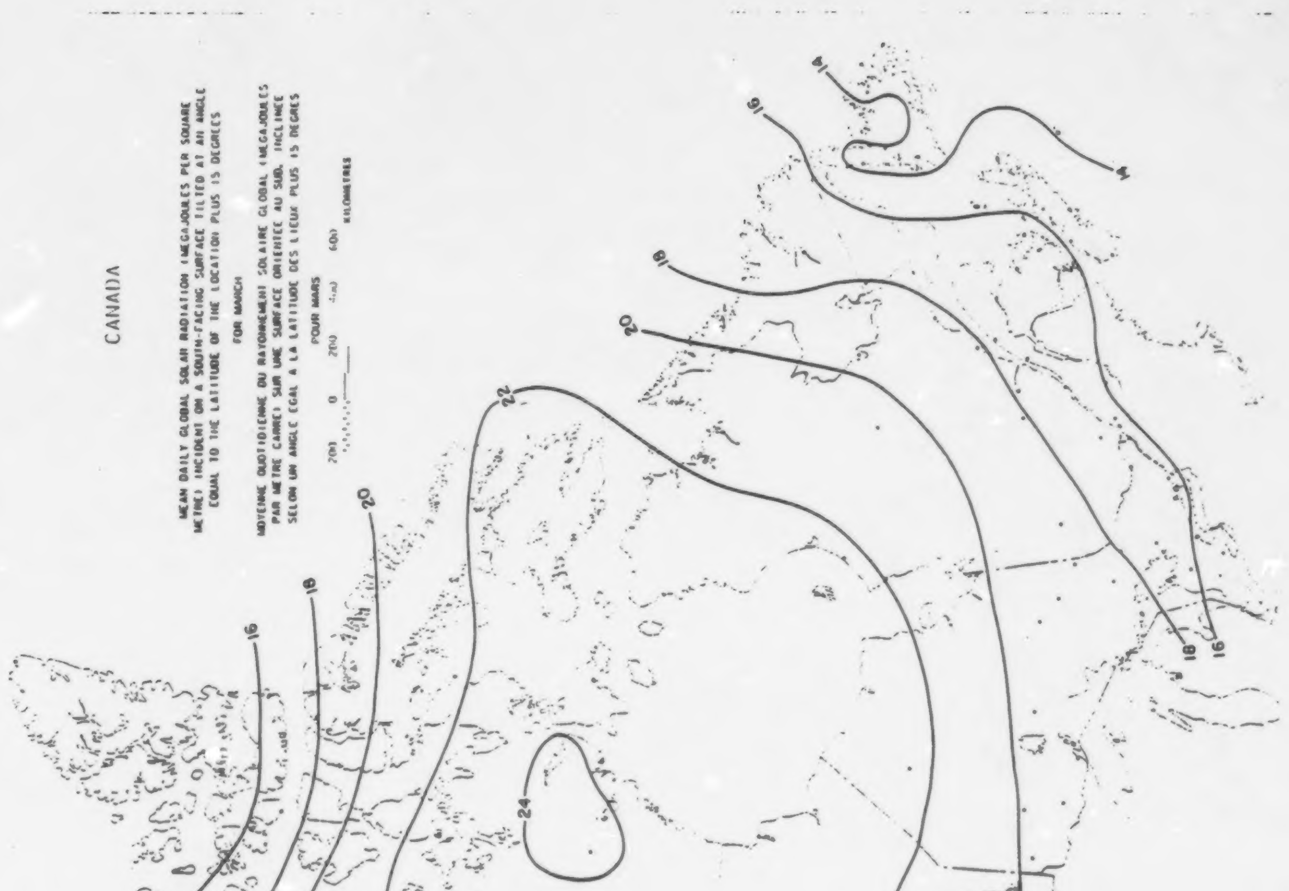

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR MARCH
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGREES
POUR MARS
200 0 200 400 600
KILOMETRES
14
16
18
20
22
24
20
18
16
16
18
16
18
18
16
18
16
14
16
14
12
10
12

FIG #: S32
MONTH: MARCH
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

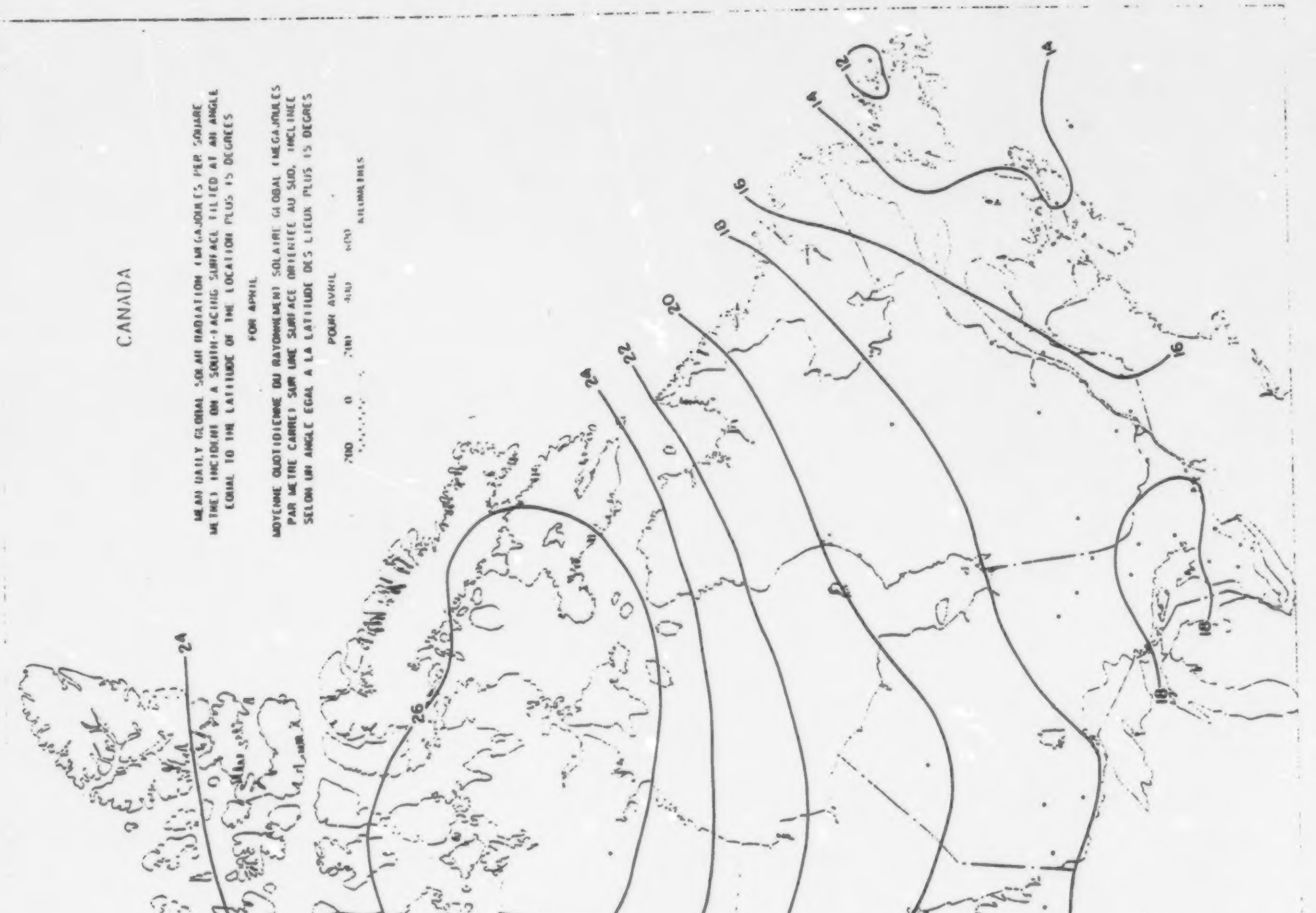

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR APRIL
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR AVRIL
200 0 200 400 600
KILOMETRES
24
26
24
22
20
18
16
14
12
14
16
18
18
22
20
18
16
14
12
14
16
14
12
14

FIG #: S33
MONTH: APRIL
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

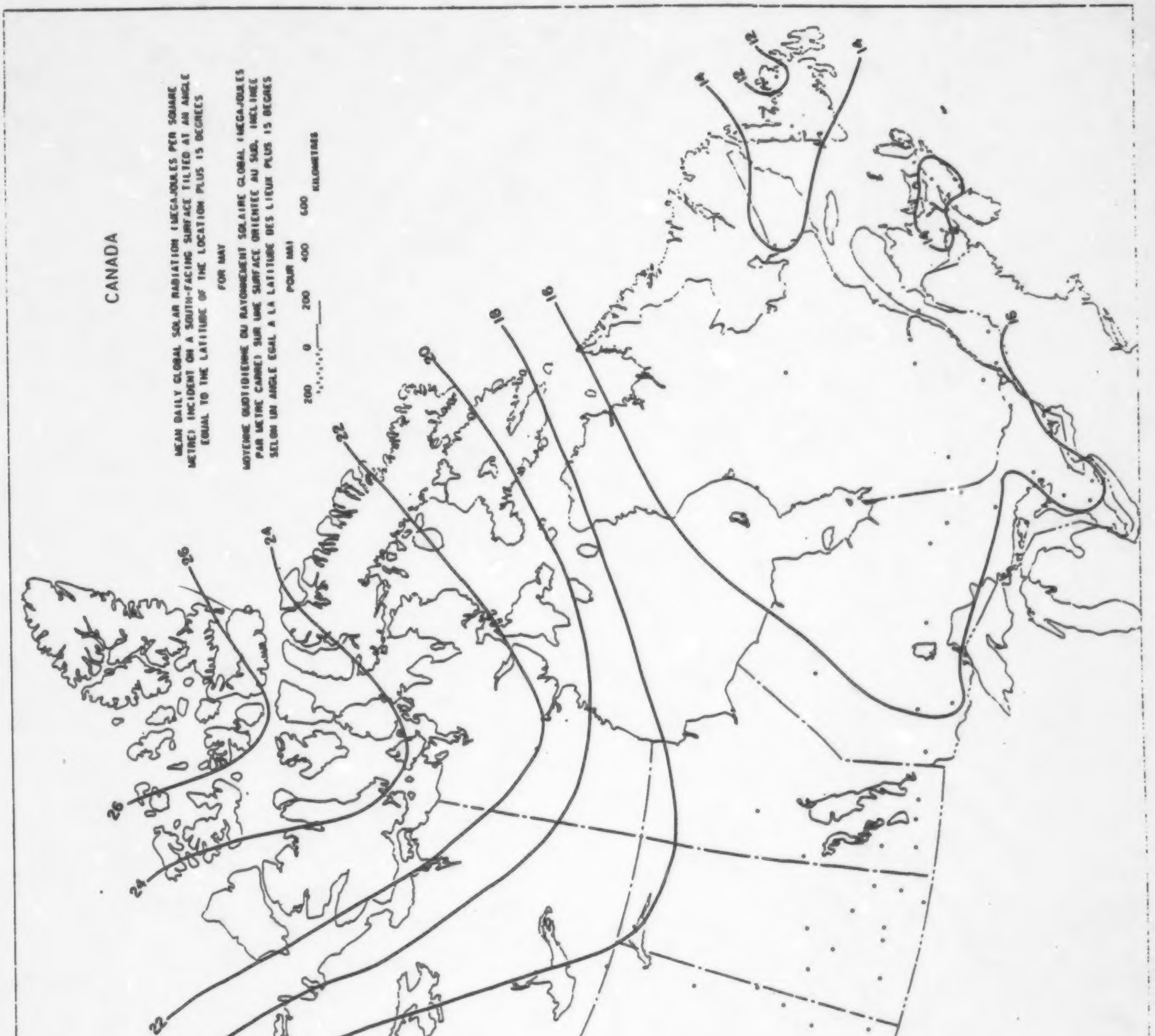

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR MAY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR MAI
200 0 200 400 600
KILOMETRES
26
24
22
20
18
16
14
12

FIG #: S34
MONTH: MAY
ANGLE: LAT +15°
UNITS: +3.6 for peak sun hours/day

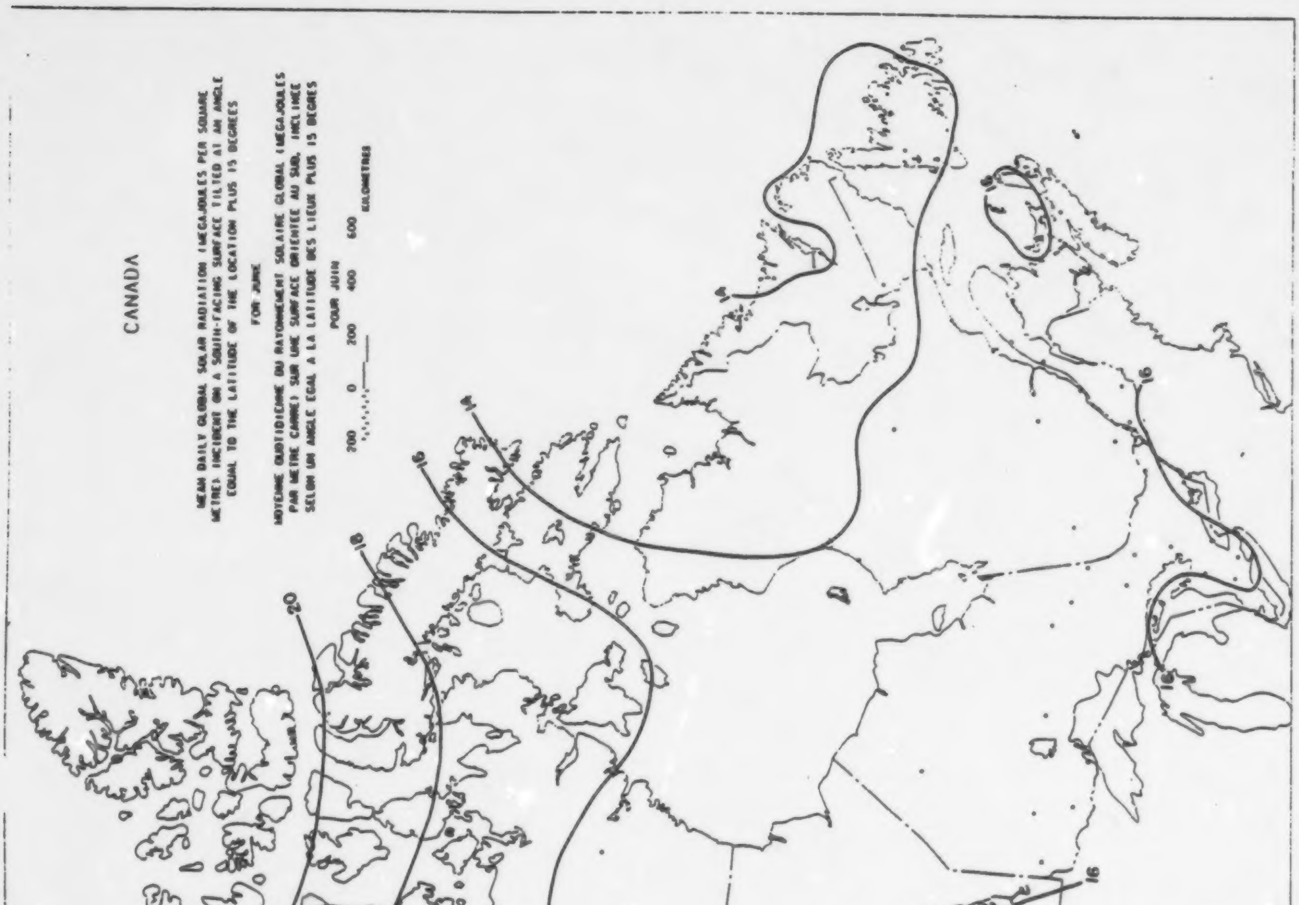

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR JUNE
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR JUIN
200 0 200 400 600
KILOMETRES
20
18
16
14

FIG #: S35
MONTH: JUNE
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

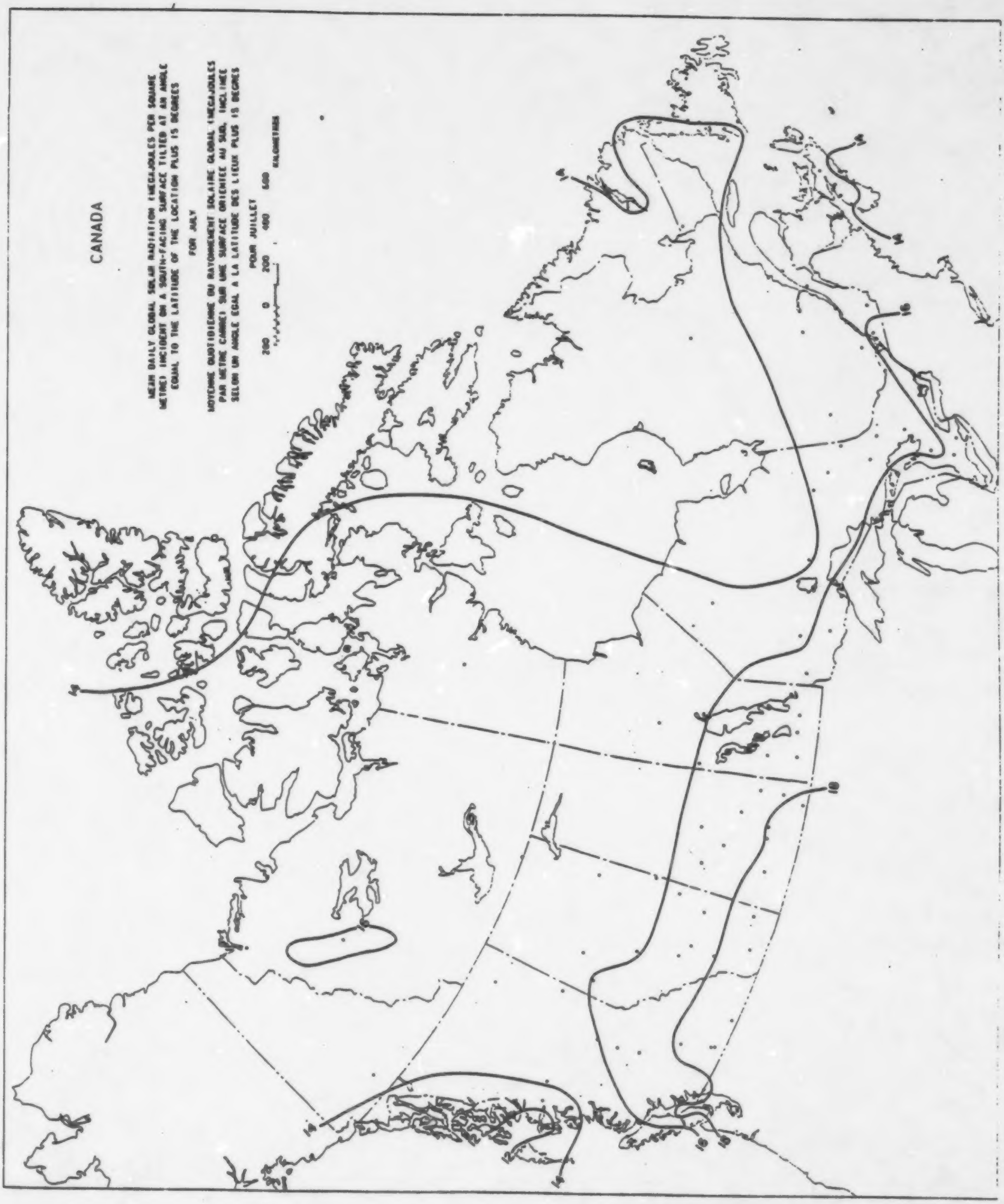

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR JULY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR JUILLET
200 0 200 400 500
KILOMETRES
16
18
14
16
18
14

FIG #: S36
MONTH: JULY
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

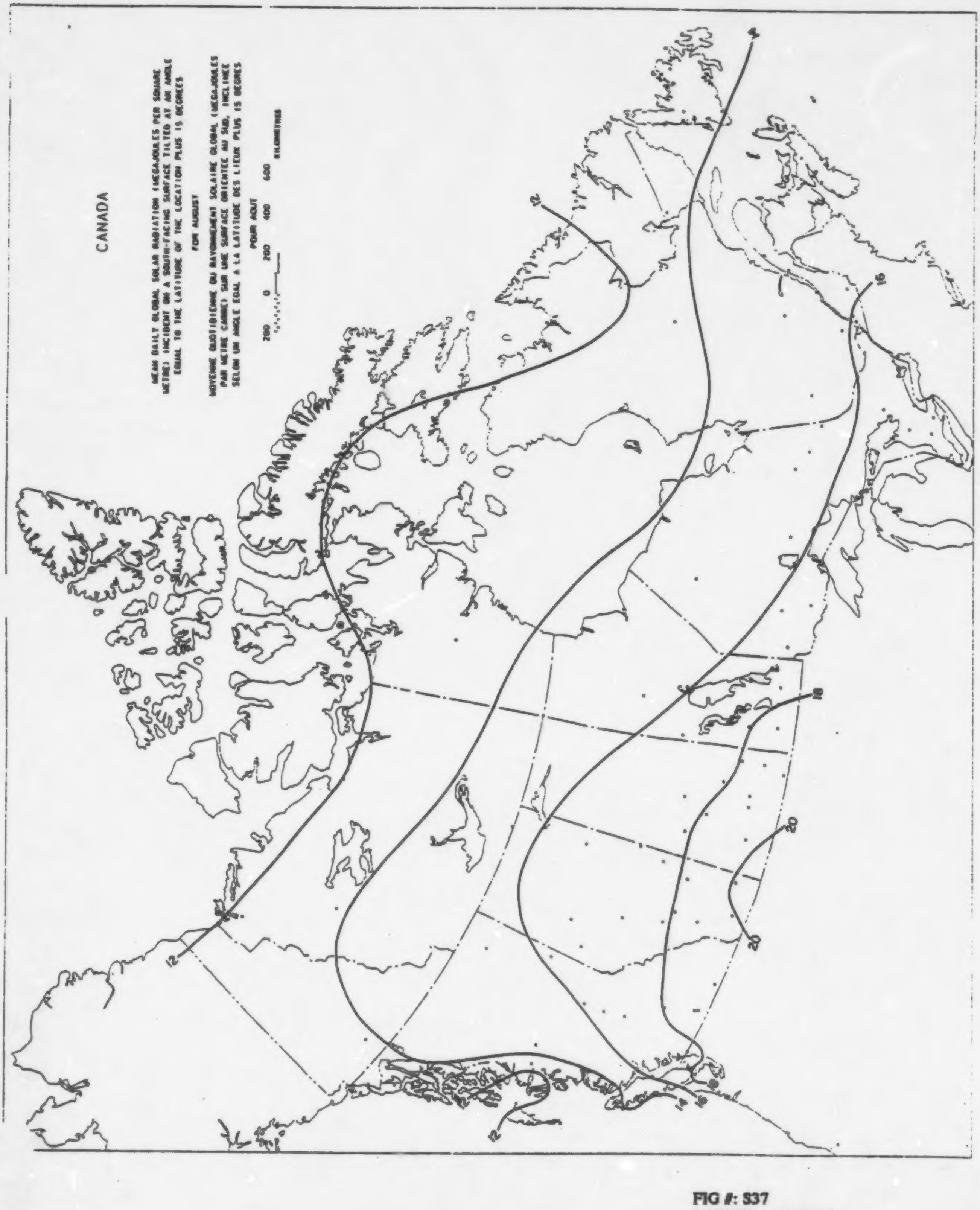

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR AUGUST
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR AOUT
200 0 200 400 600
KILOMETRES
4
12
16
18
20
20
12
14
16
18
12

FIG #: S37
MONTH: AUGUST
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

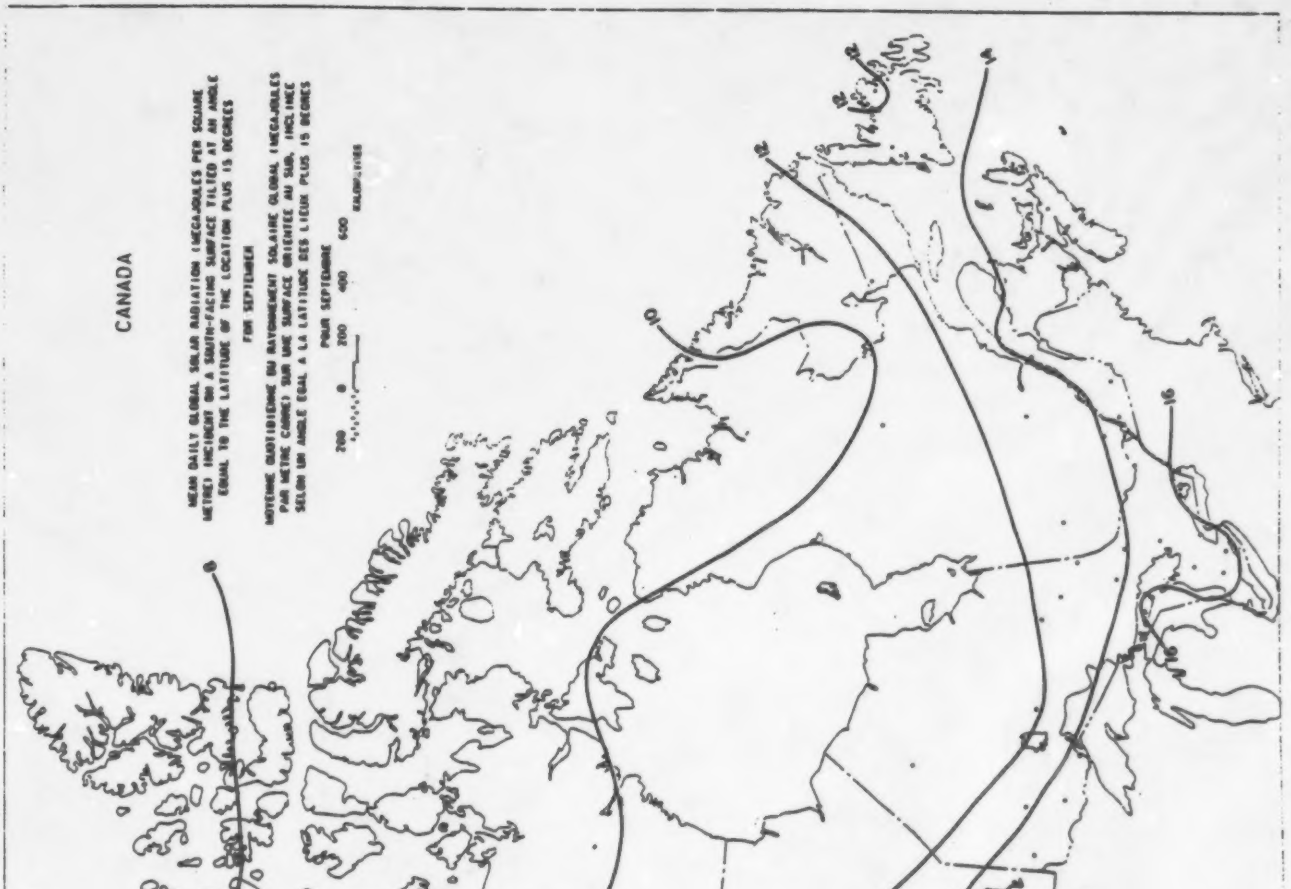

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR SEPTEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGREES
POUR SEPTEMBRE
200 0 200 400 600
KILOMETRES
8
10
12
14
16
18

FIG #: S38
MONTH: SEPTEMBER
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

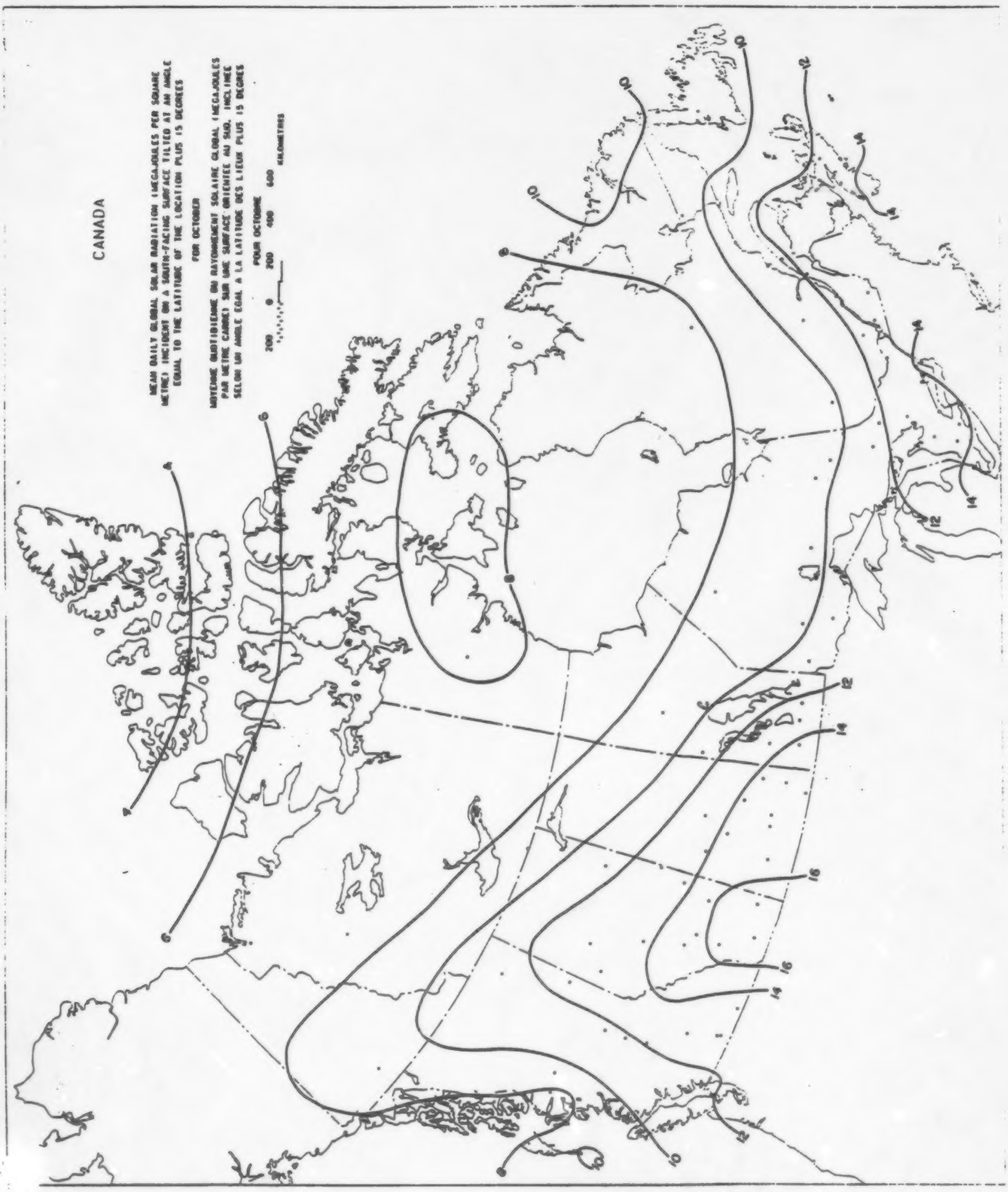

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR OCTOBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR OCTOBRE
200 0 200 400 600
KILOMETRES
4
4
6
6
8
8
10
10
10
12
12
12
14
14
14
16
16

FIG #: S39
MONTH: OCTOBER
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

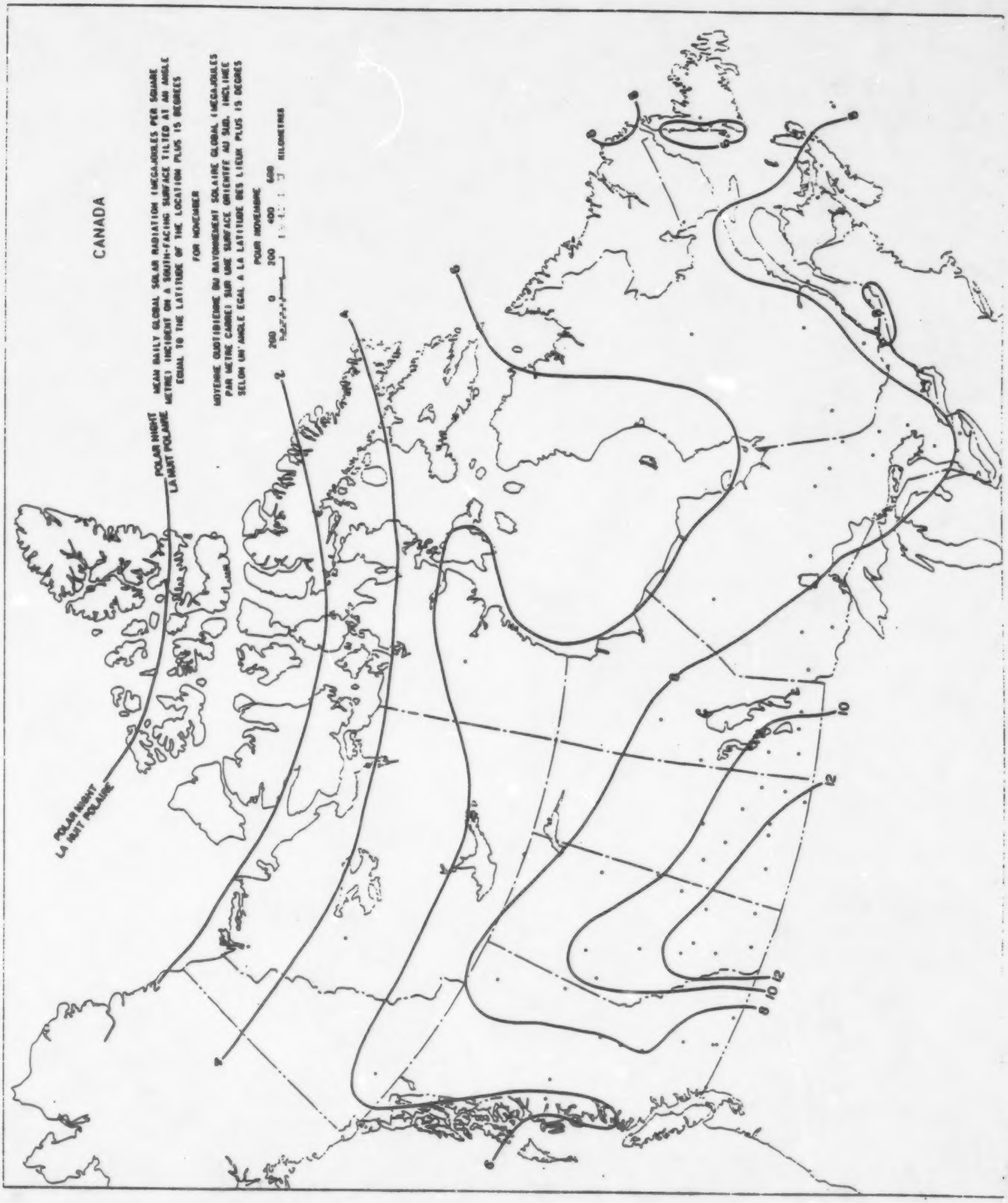
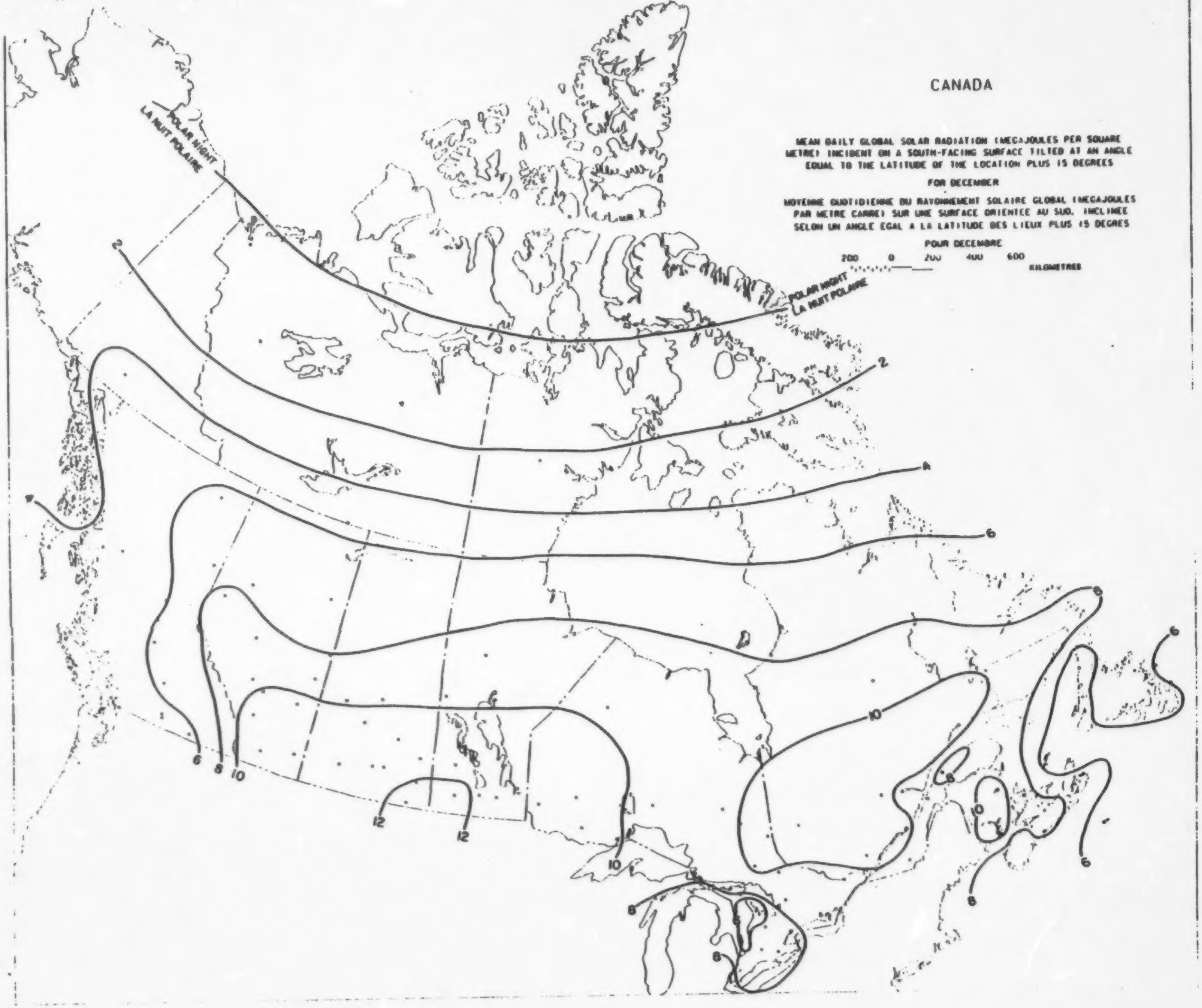

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES
FOR NOVEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES
POUR NOVEMBRE
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10
12
8
10
12
6
6
4
6

FIG #: S40
MONTH: NOVEMBER
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day



CANADA

MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION PLUS 15 DEGREES

FOR DECEMBER

MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX PLUS 15 DEGRES

POUR DECEMBRE

FIG #: S41
MONTH: DECEMBER
ANGLE: LAT +15°
UNITS: ÷3.6 for peak sun hours/day

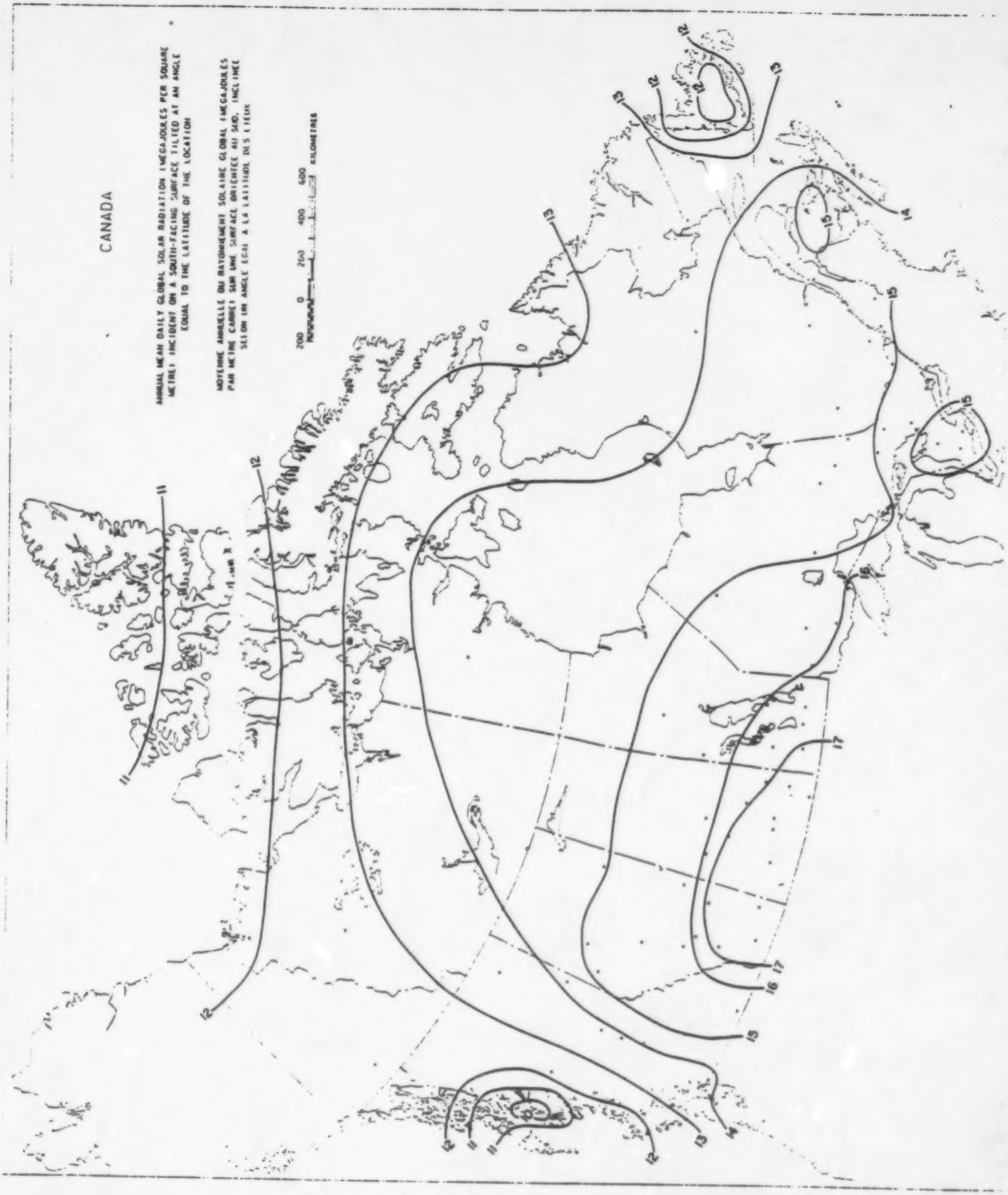
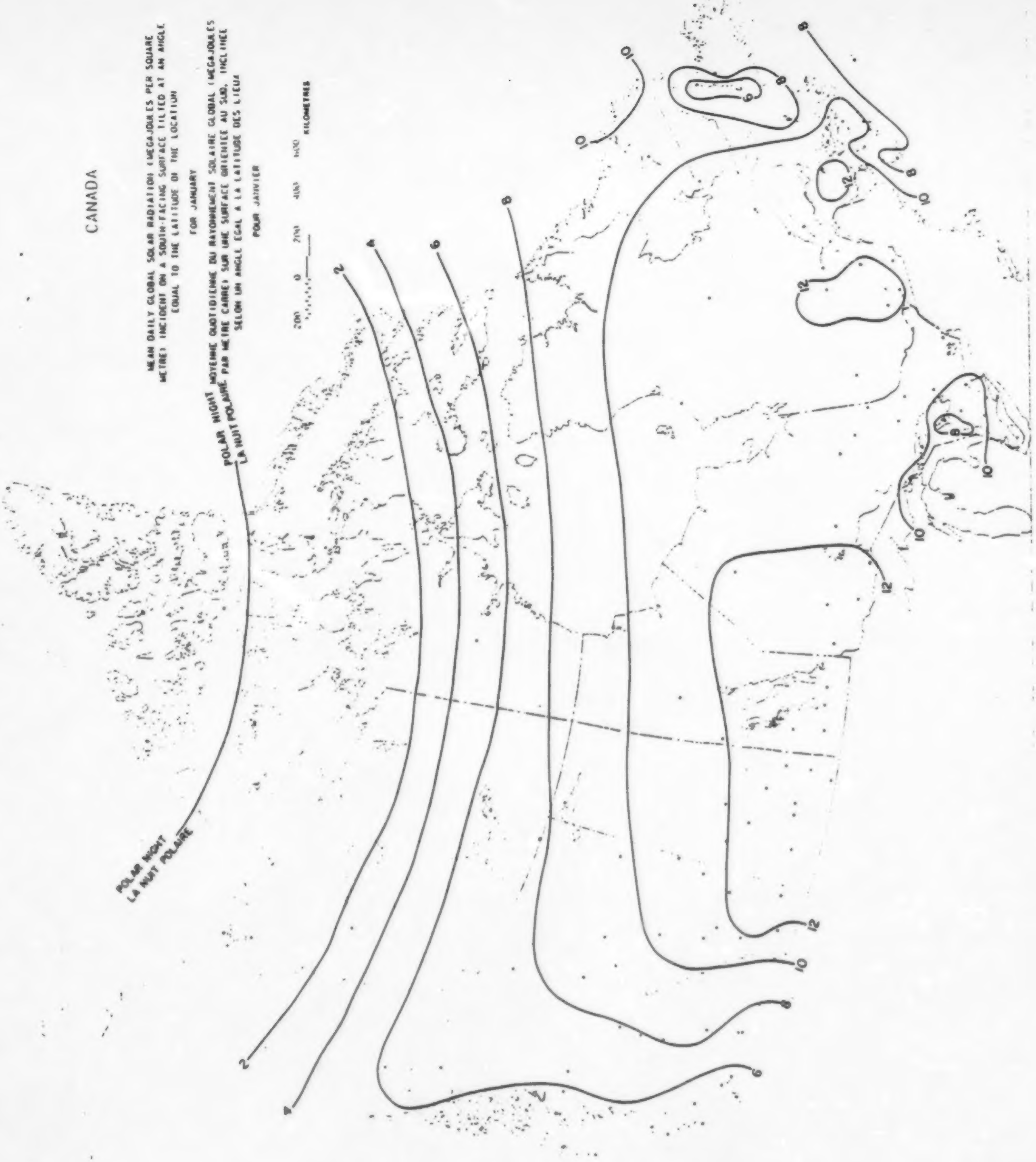

CANADA
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
MOYENNE ANNUELLE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
200 0 200 400 600 KILOMETRES
11
12
13
14
15
16
17

FIG #: S42
MONTH: ANNUAL AVERAGE
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day



CANADA

MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION

FOR JANUARY

MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX

POUR JANVIER

FIG #: S43
MONTH: JANUARY
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

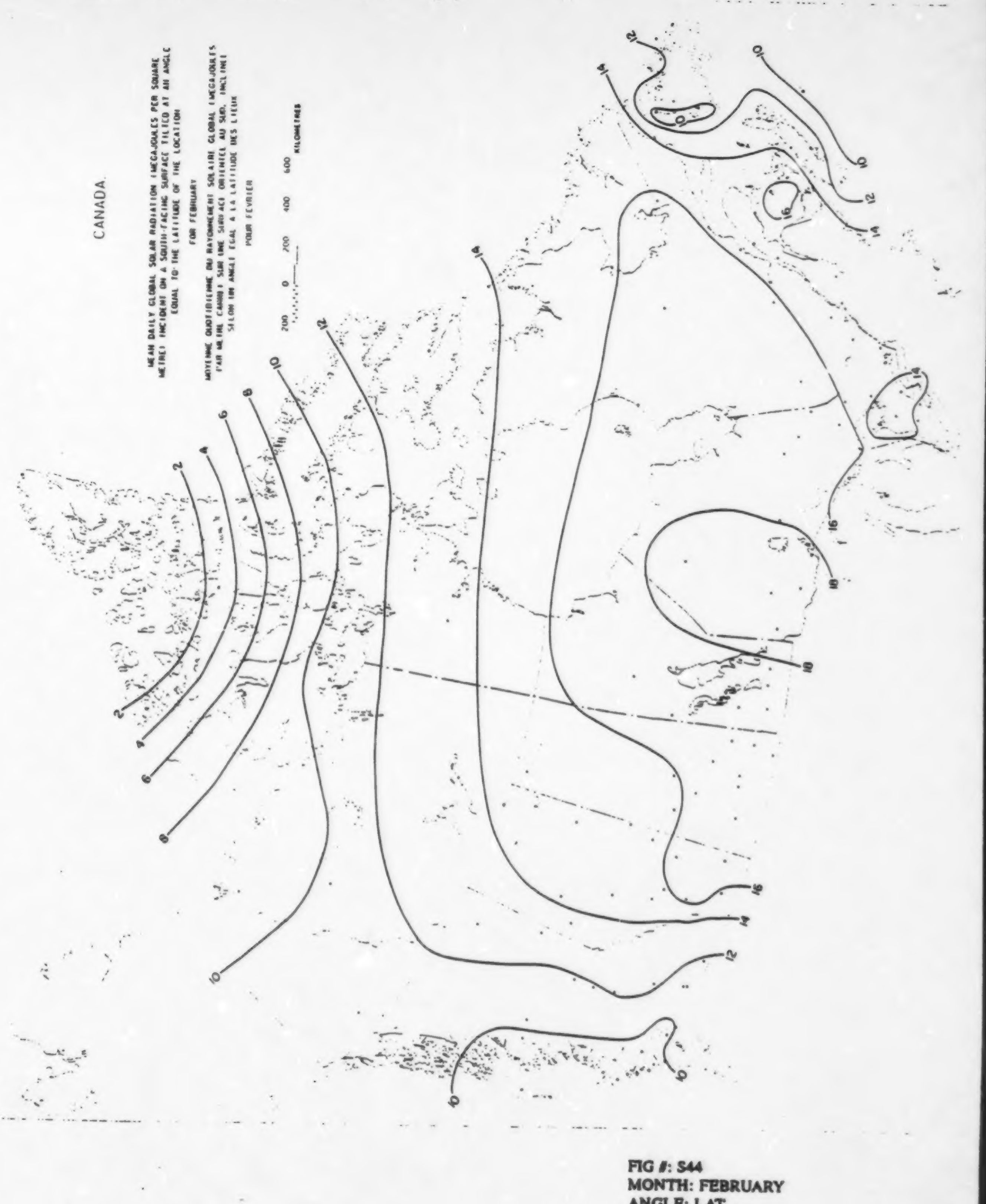

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR FEBRUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR FEVRIER
200 0 200 400 600 KILOMETRES
2
4
6
8
10
12
14
16
18

FIG #: S44
MONTH: FEBRUARY
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

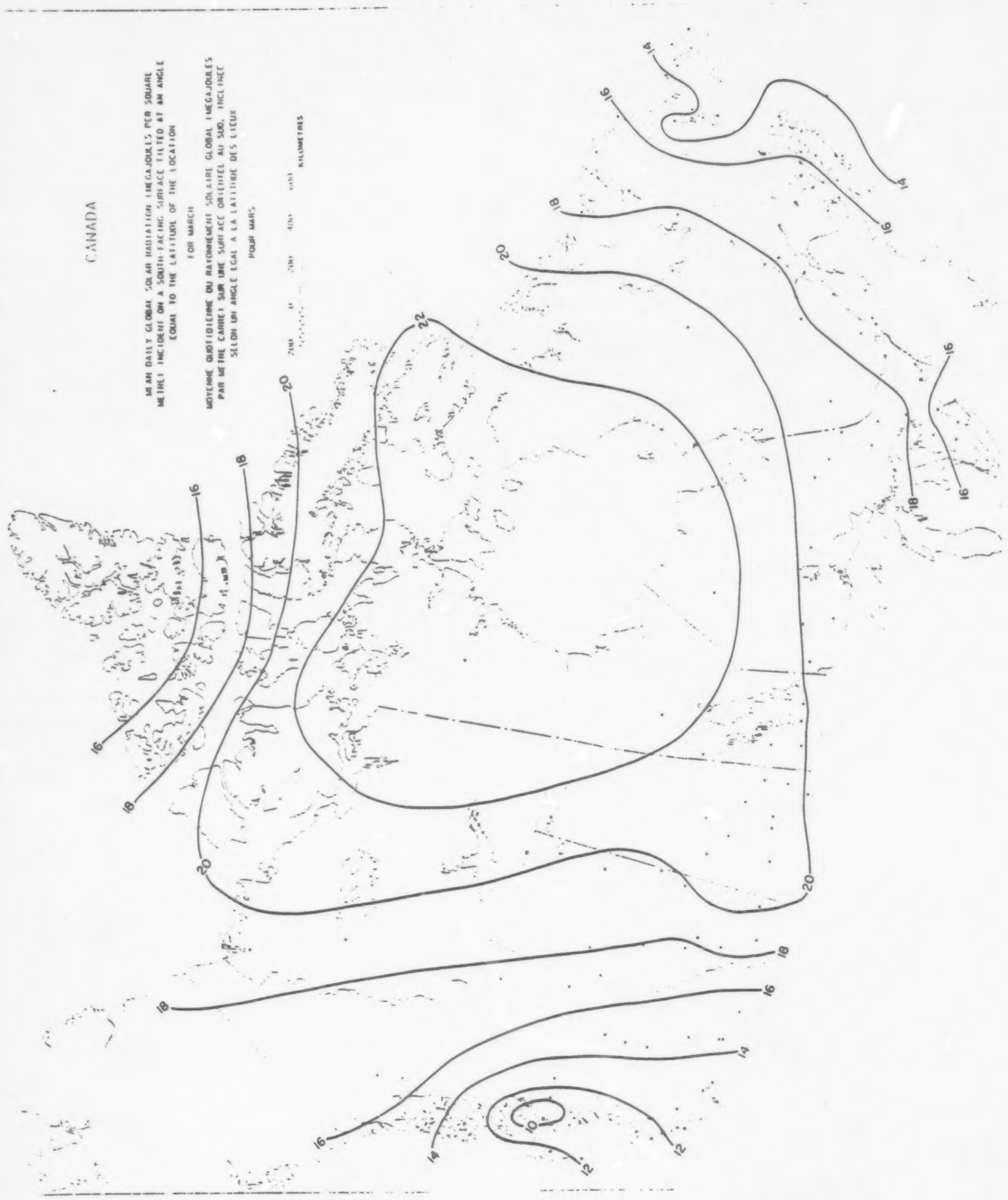

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR MARCH
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR MARS
200 0 200 400 600 KILOMETRES
14
16
14
16
18
20
22
16
18
16
16
18
20
20
18
20
18
16
14
16
10
12
14
12

FIG #: S45
MONTH: MARCH
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

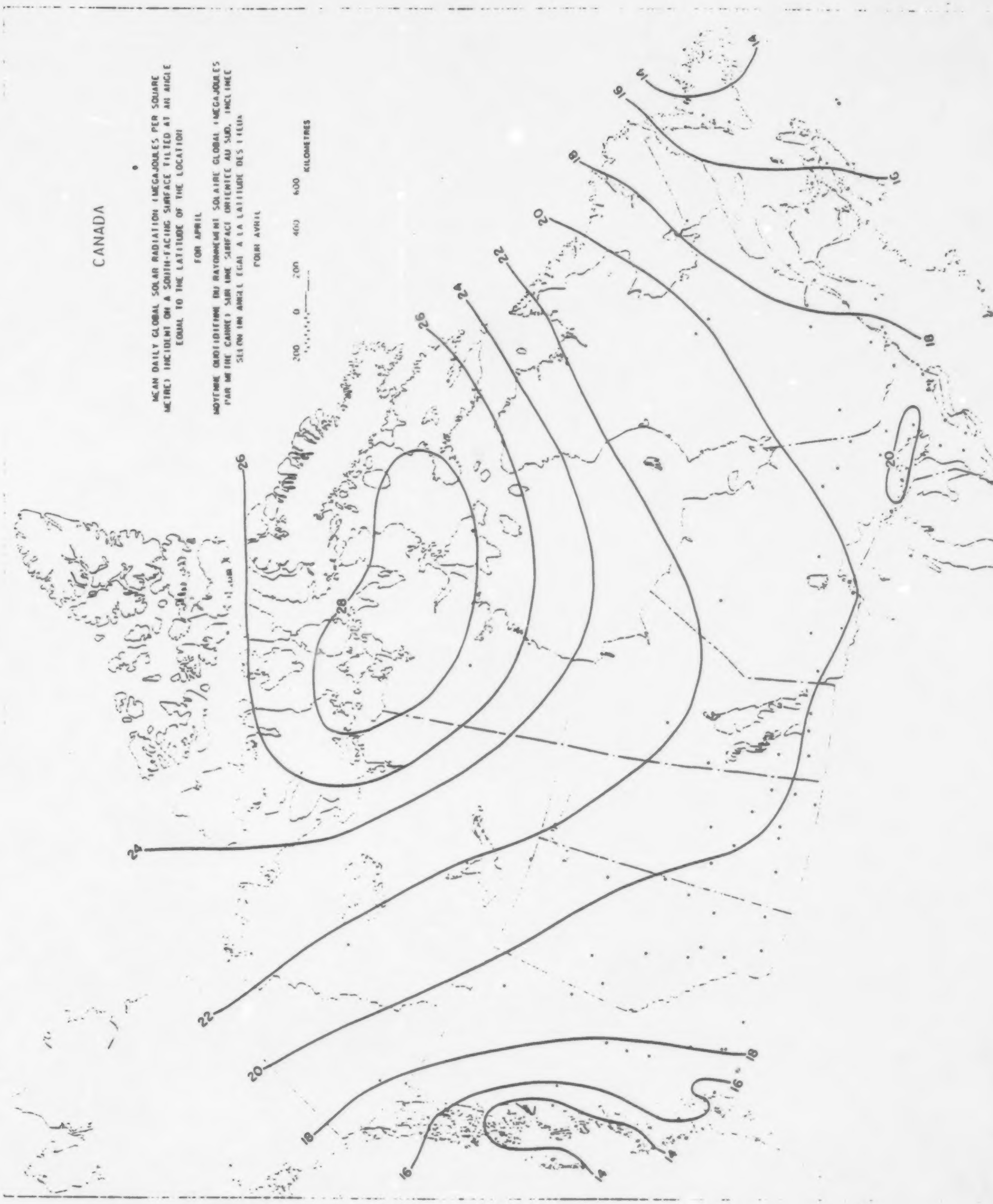

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR APRIL
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR AVRIL
200 0 200 400 600
KILOMETRES
14
16
16
18
20
22
24
26
26
28
24
20
18
22
20
18
16
16
14
14

FIG #: S46
MONTH: APRIL
ANGLE: LAT
UNITS: +3.6 for peak sun hours/day

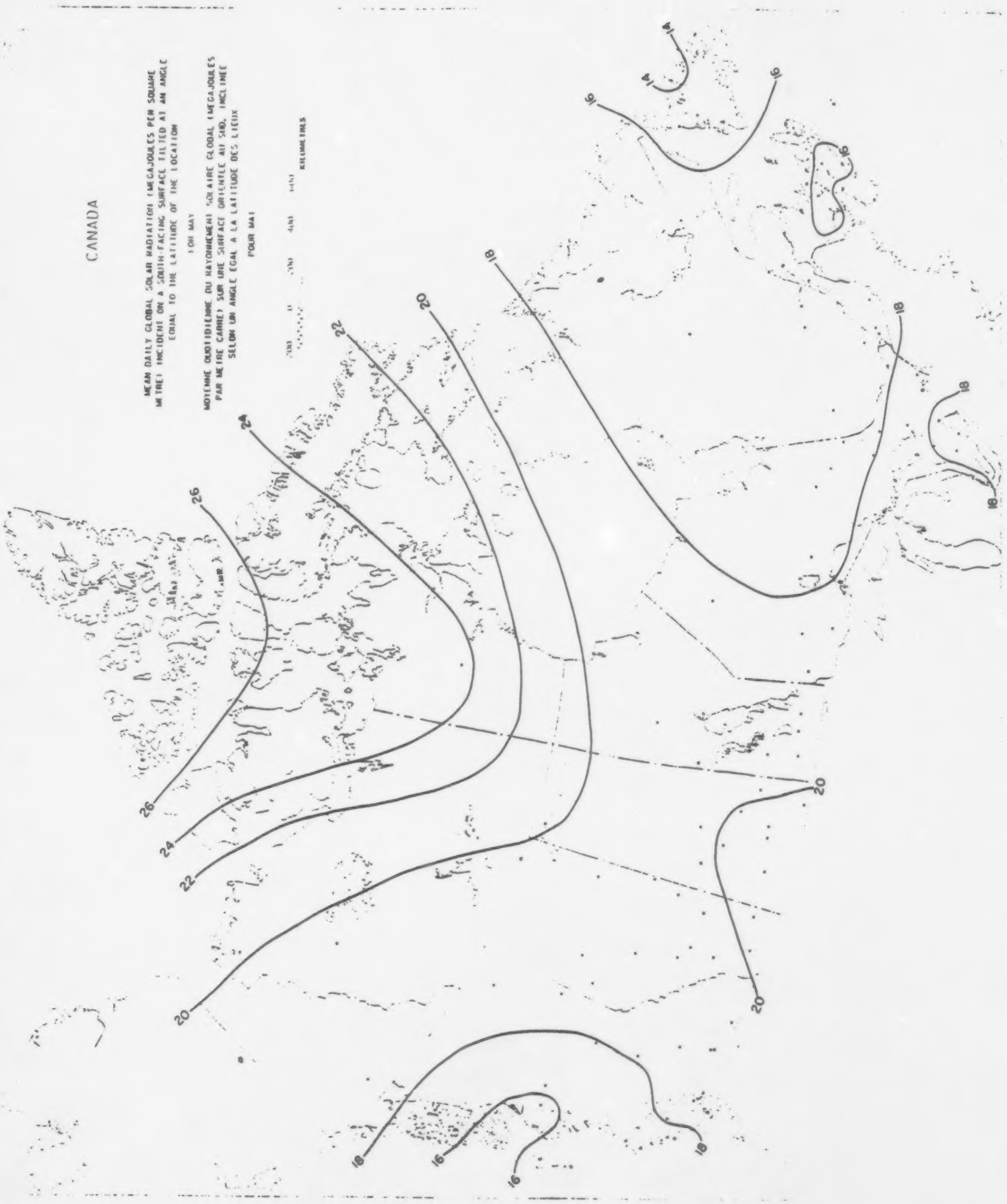
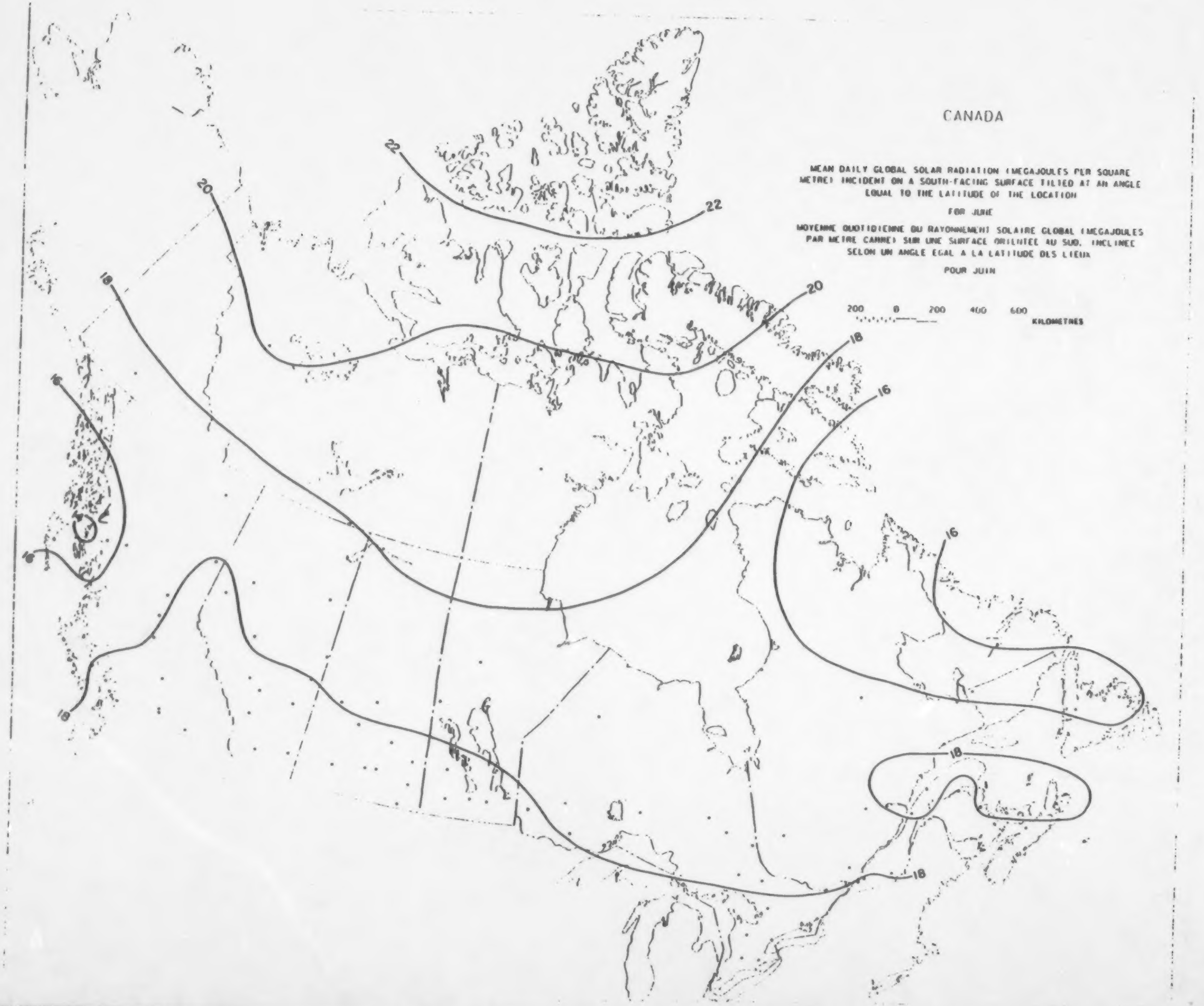

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR MAY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR MAI
200 0 200 400 600
KILOMETRES
26
24
22
20
18
16
14

FIG #: S47
MONTH: MAY
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day



CANADA

MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION

FOR JUNE

MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX

POUR JUIN

FIG #: S48
MONTH: JUNE
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

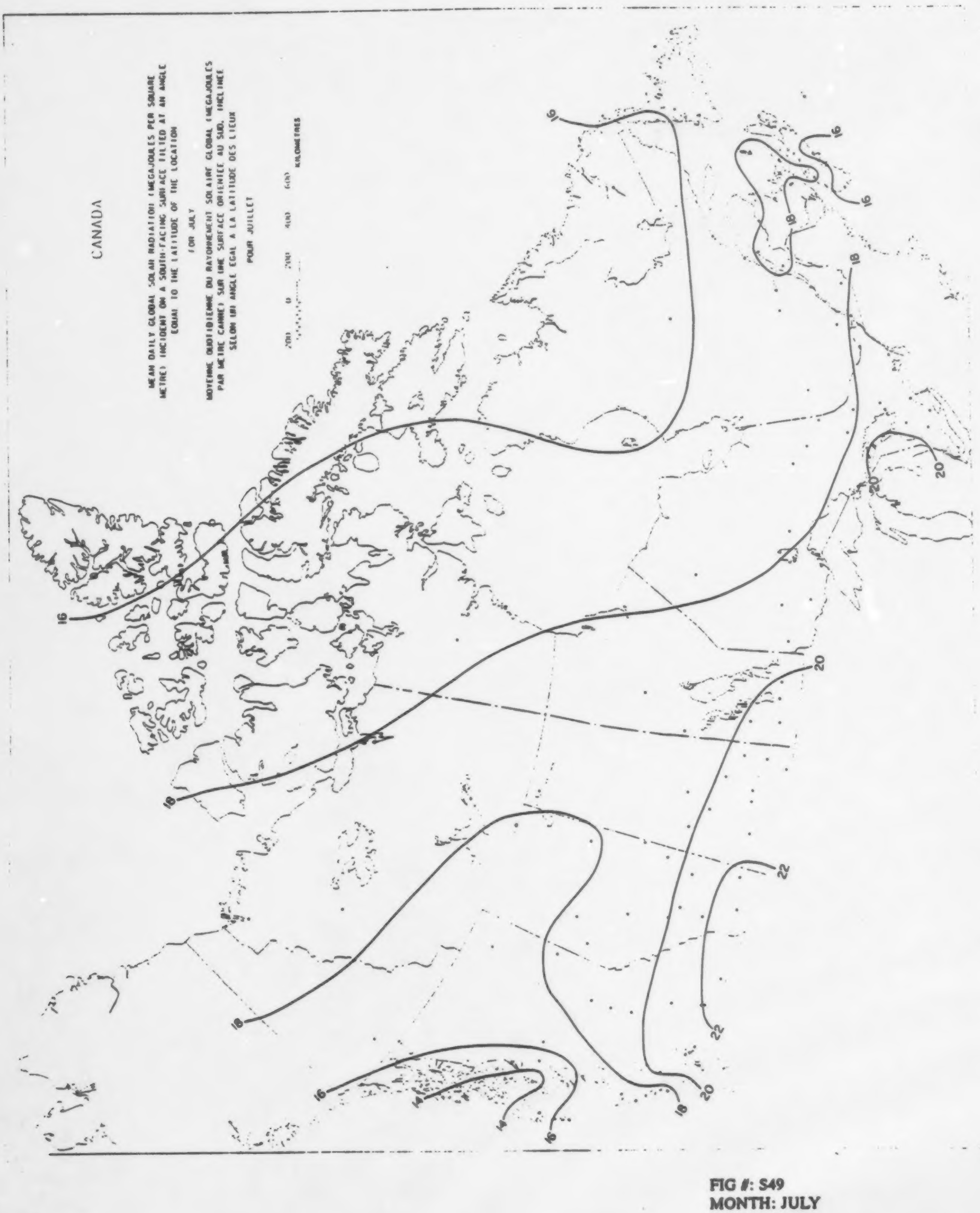

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR JULY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR JUILLET
200
0
200
400
600
KILOMETRES
16
16
16
18
18
18
16
20
20
18
20
22
22
18
18
20
16
14
14
16

FIG #: S49
MONTH: JULY
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

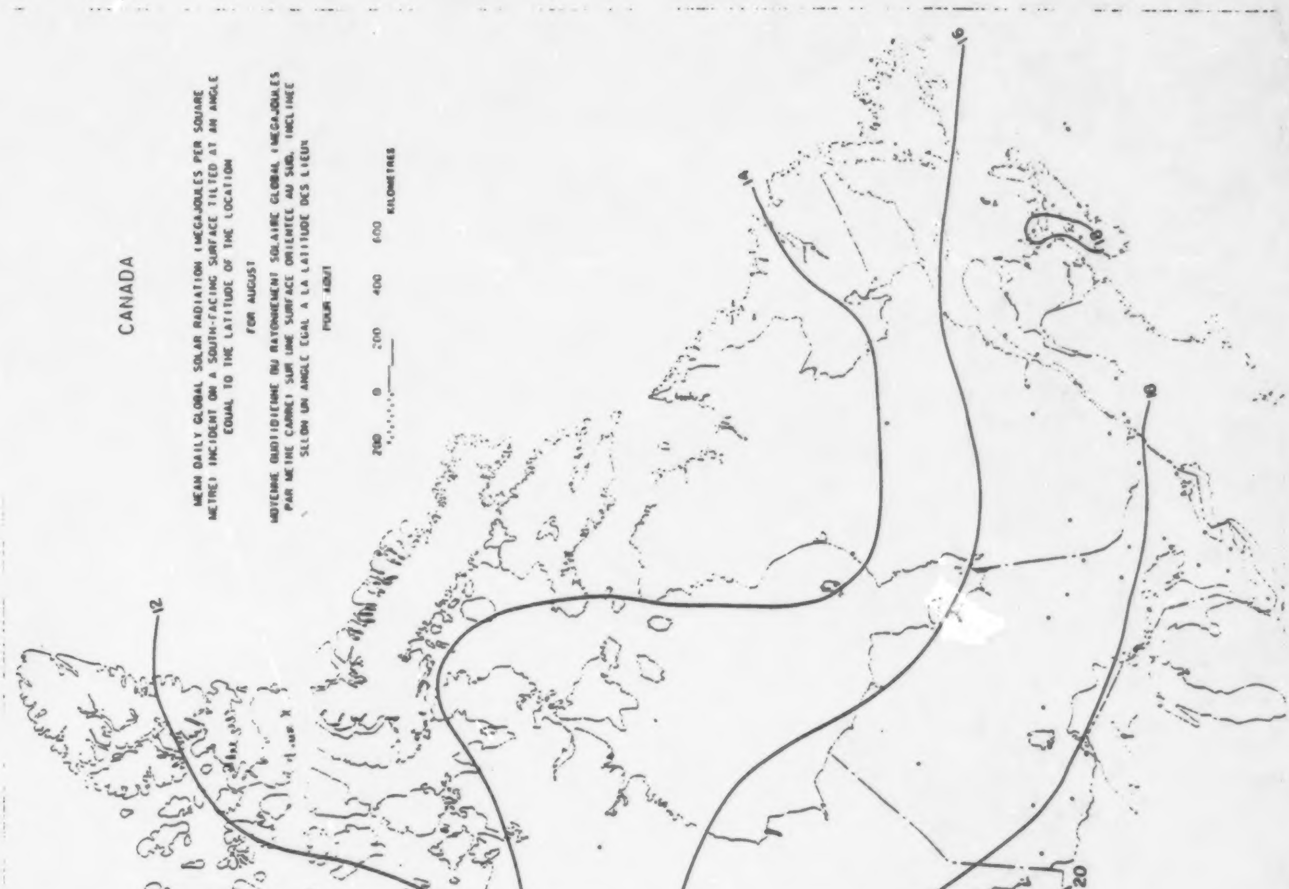
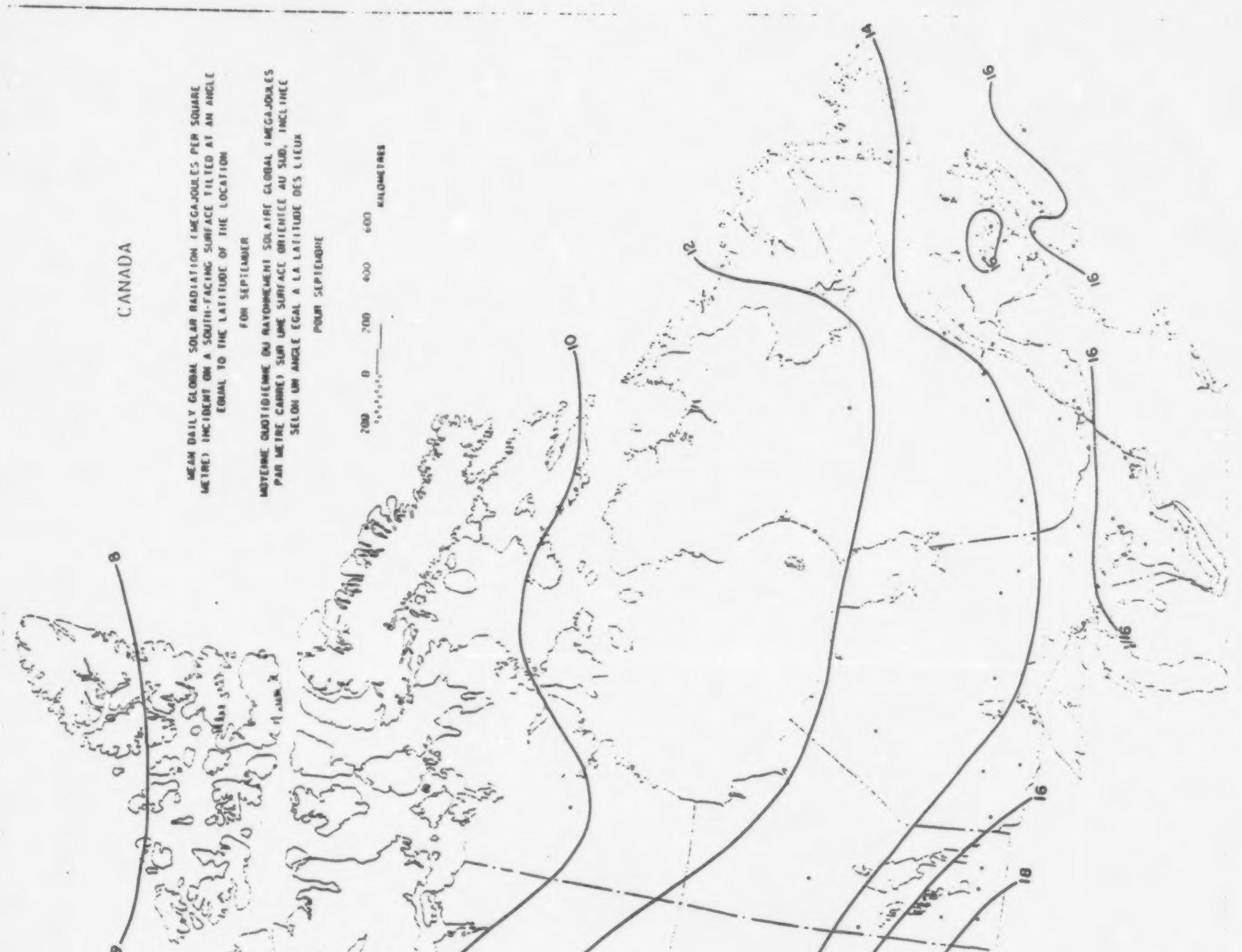

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR AUGUST
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR AOUT
200 0 200 400 600 KILOMETRES
12
12
14
14
16
16
18
18
18
20
20
22
22
14
16
12
14

FIG #: S50
MONTH: AUGUST
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day



CANADA

MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION

FOR SEPTEMBER

MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX

POUR SEPTEMBRE

FIG #: S51
MONTH: SEPTEMBER
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

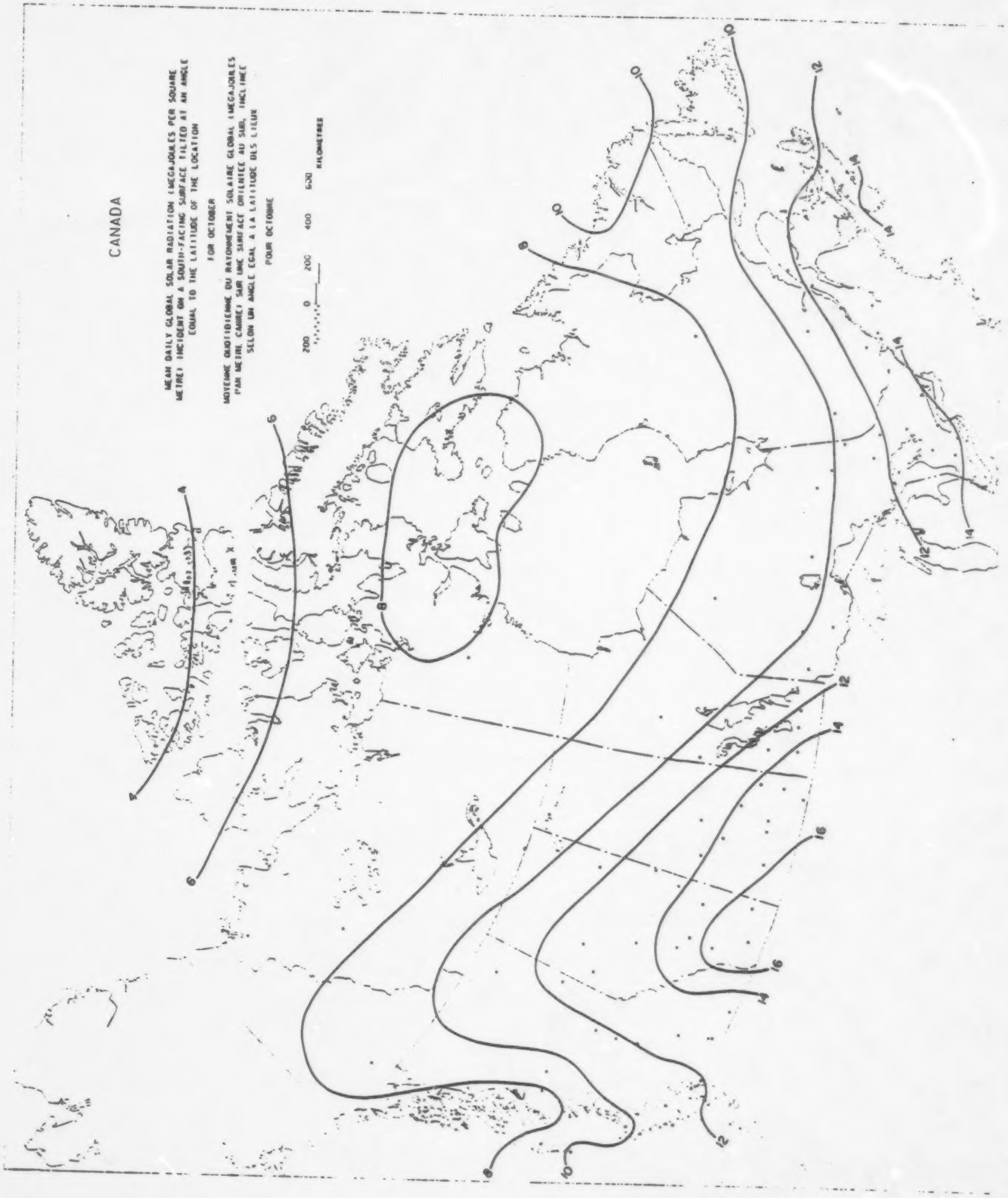

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR OCTOBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR OCTOBRE
200
0
200
400
600
KILOMETRES
4
4
6
6
8
8
8
10
10
10
10
12
12
12
12
14
14
14
14
16
16

FIG #: S52
MONTH: OCTOBER
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

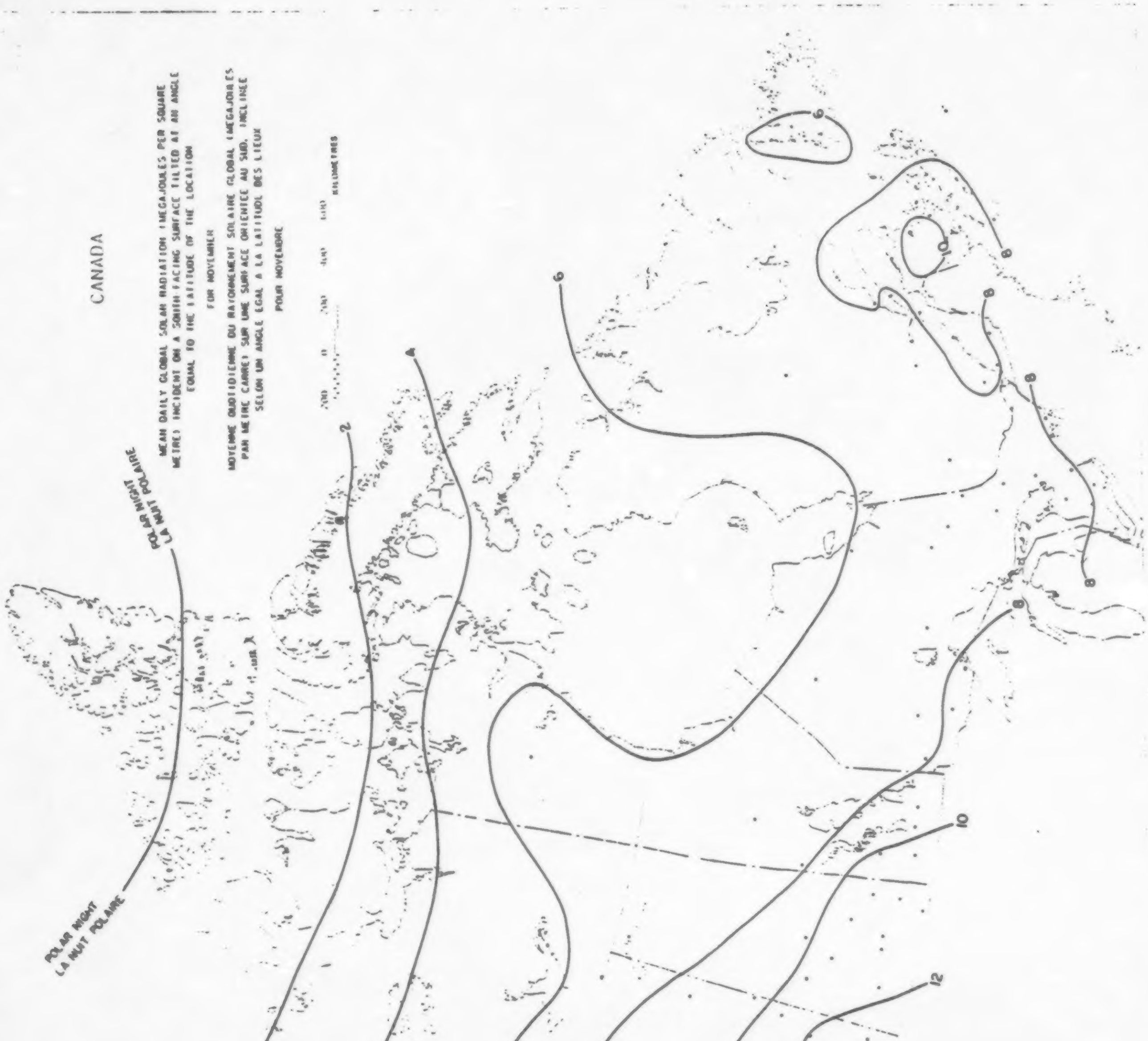

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR NOVEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR NOVEMBRE
200 0 200 400 600
KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10
12
2
4
6
6
8
8
8
8
10
10
12

FIG #: S53
MONTH: NOVEMBER
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

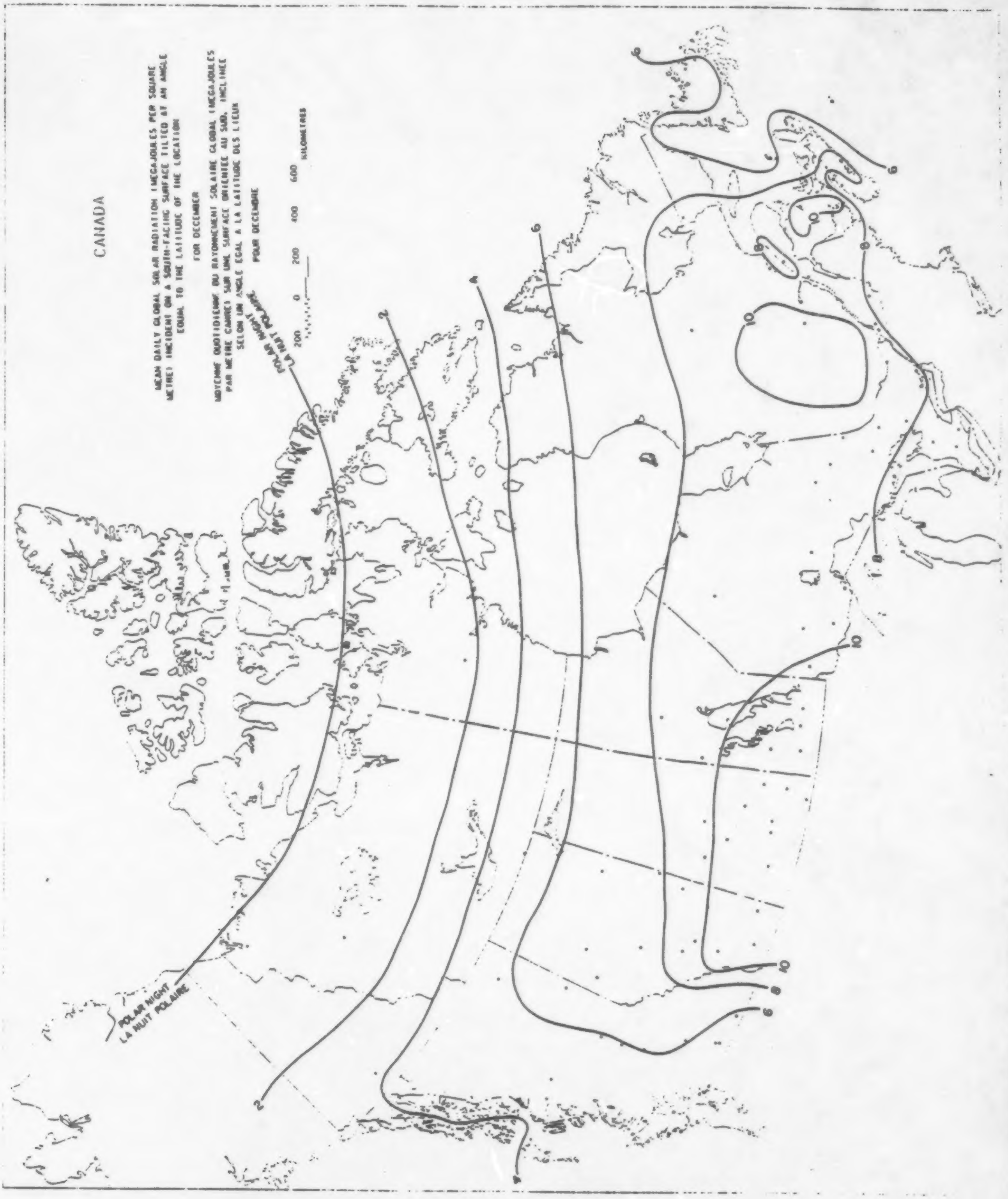

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A SOUTH-FACING SURFACE TILTED AT AN ANGLE EQUAL TO THE LATITUDE OF THE LOCATION
FOR DECEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE ORIENTEE AU SUD, INCLINEE SELON UN ANGLE EGAL A LA LATITUDE DES LIEUX
POUR DECEMBRE
200 0 200 400 600
KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
2
4
6
8
10

FIG #: S54
MONTH: DECEMBER
ANGLE: LAT
UNITS: ÷3.6 for peak sun hours/day

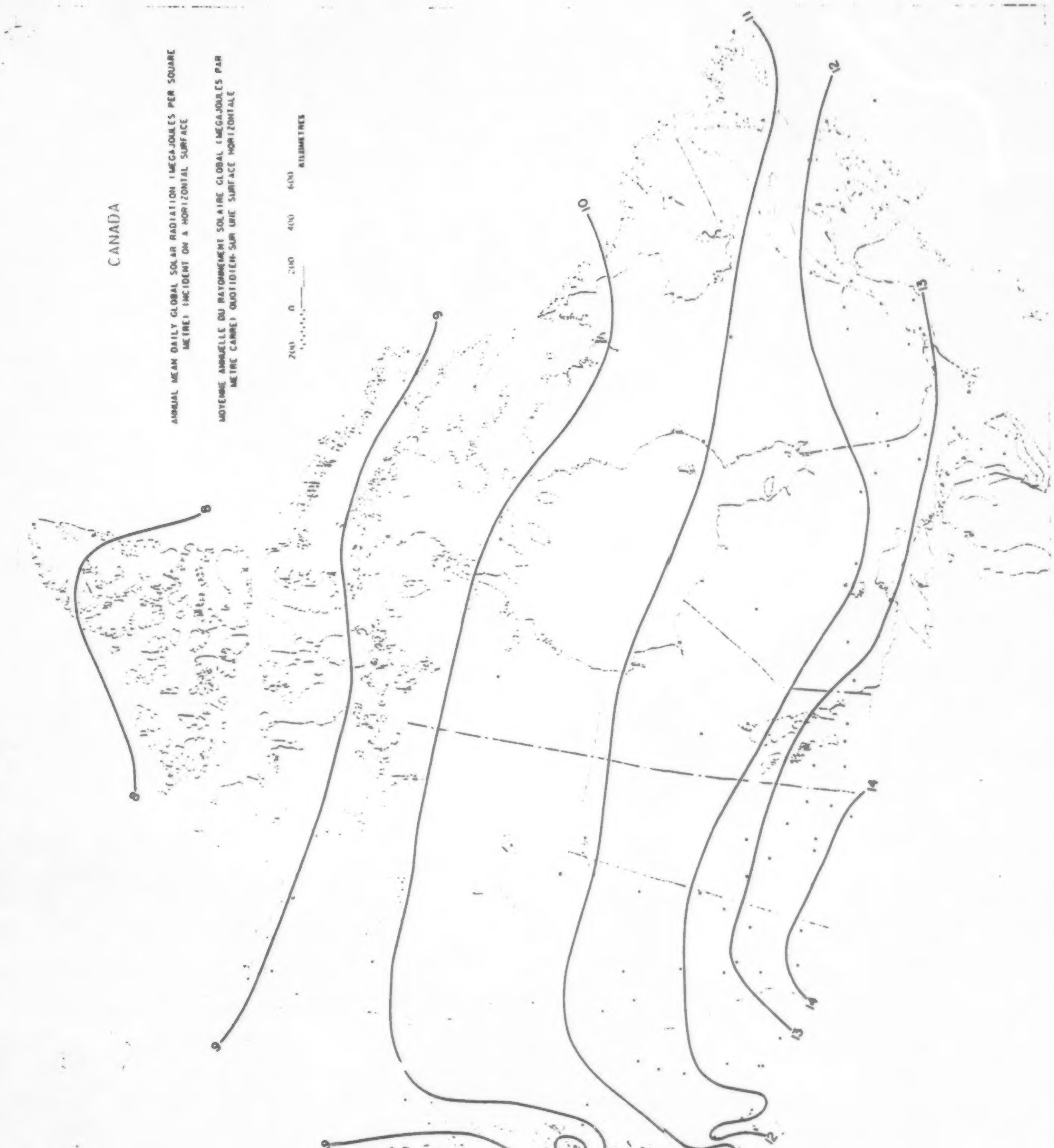

CANADA
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
MOYENNE ANNUELLE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) QUOTIDIEN SUR UNE SURFACE HORIZONTALE
200 0 200 400 600
KILOMETRES
8
8
8
9
9
9
9
9
10
10
11
11
12
12
13
13
14
14

FIG #: S55
MONTH: ANNUAL AVERAGE
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

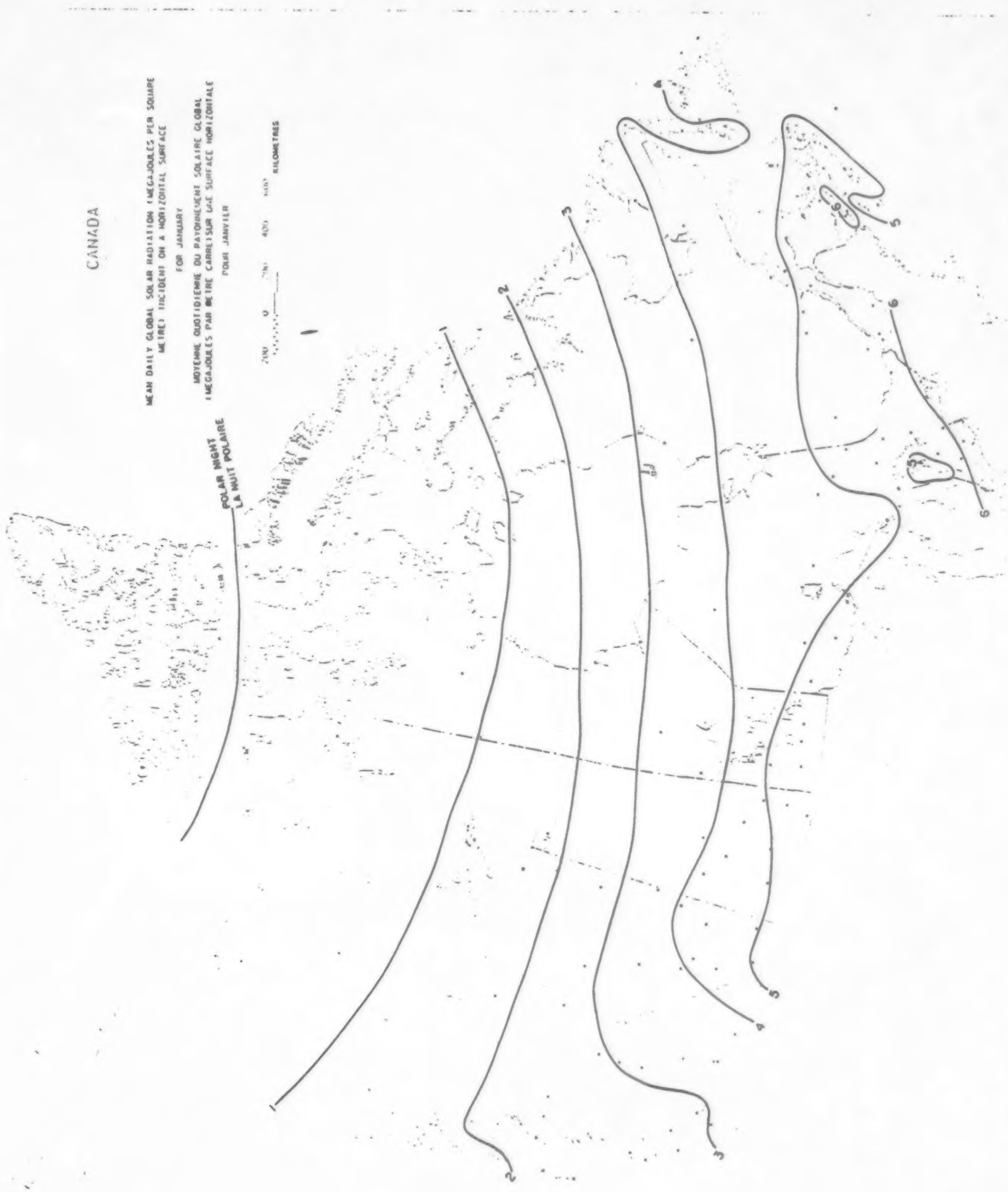

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR JANUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR JANVIER
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
1
1
2
2
3
3
4
4
5
5
5
6
6
6
6

FIG #: S56
MONTH: JANUARY
ANGLE: 0°
UNITS: +3.6 for peak sun hours/day

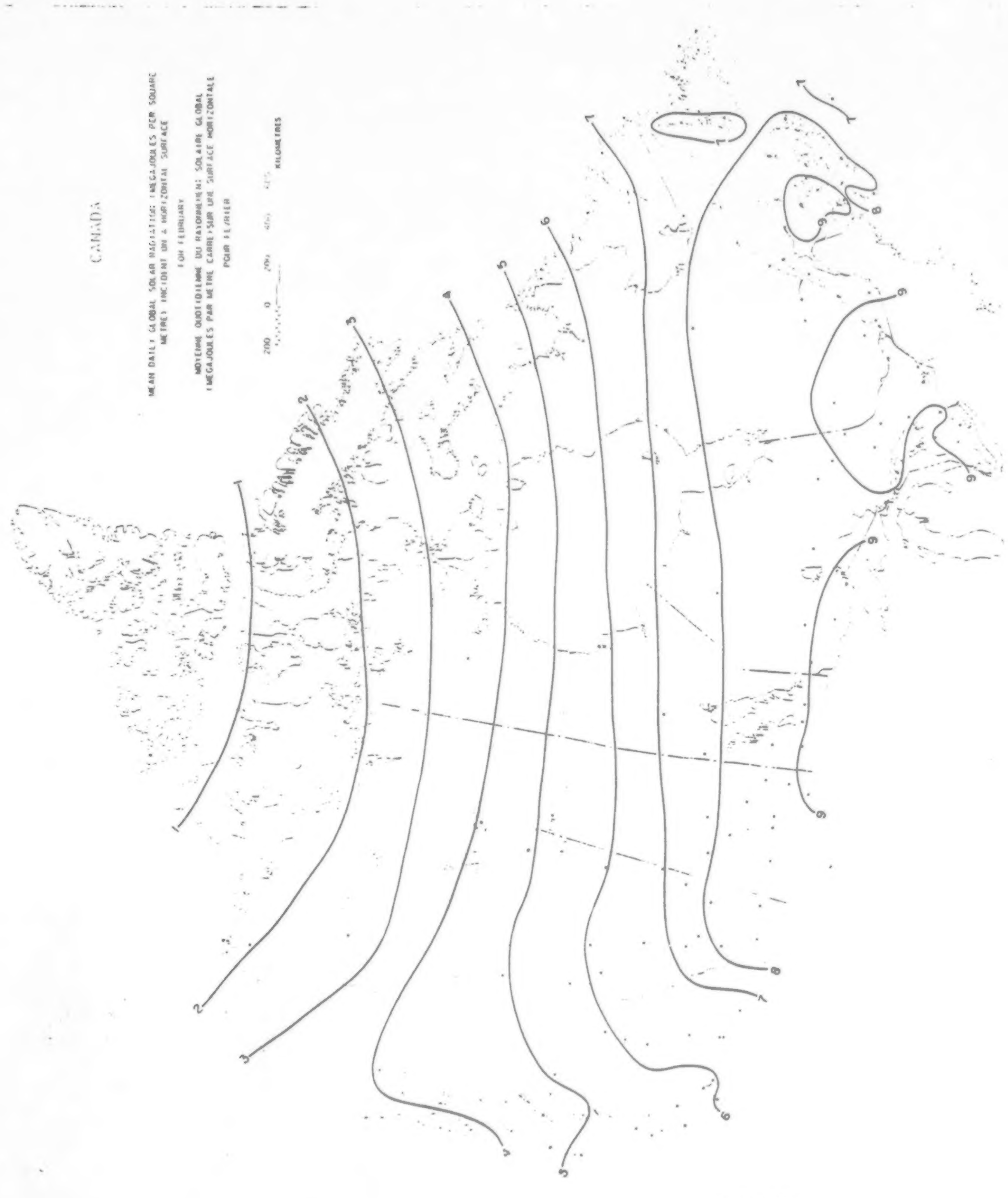

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRES) INCIDENT ON A HORIZONTAL SURFACE
FOR FEBRUARY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR FEVRIER
200 0 200 400 600 KILOMETRES
1
2
3
4
5
6
7
8
9

FIG #: S57
MONTH: FEBRUARY
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

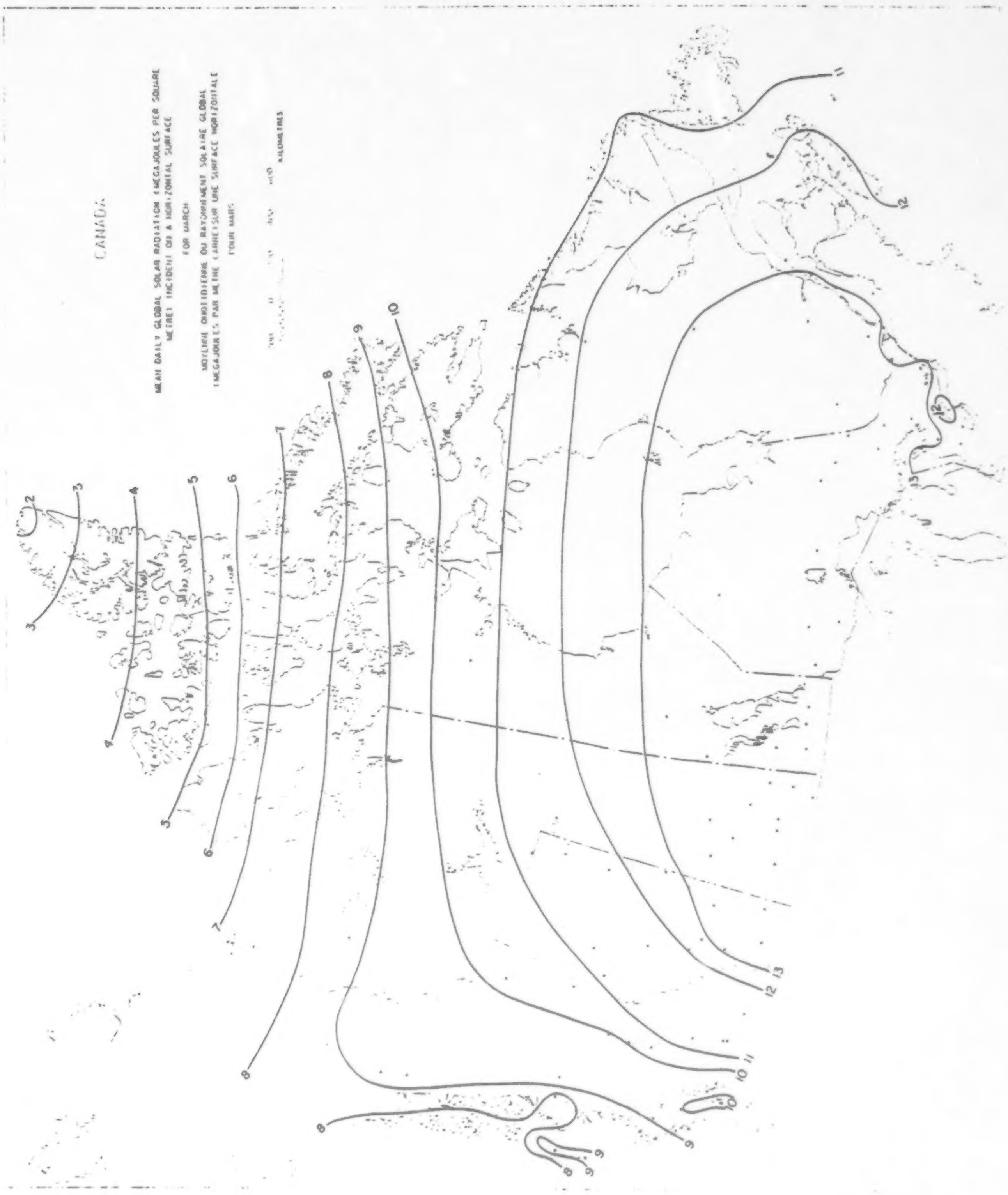
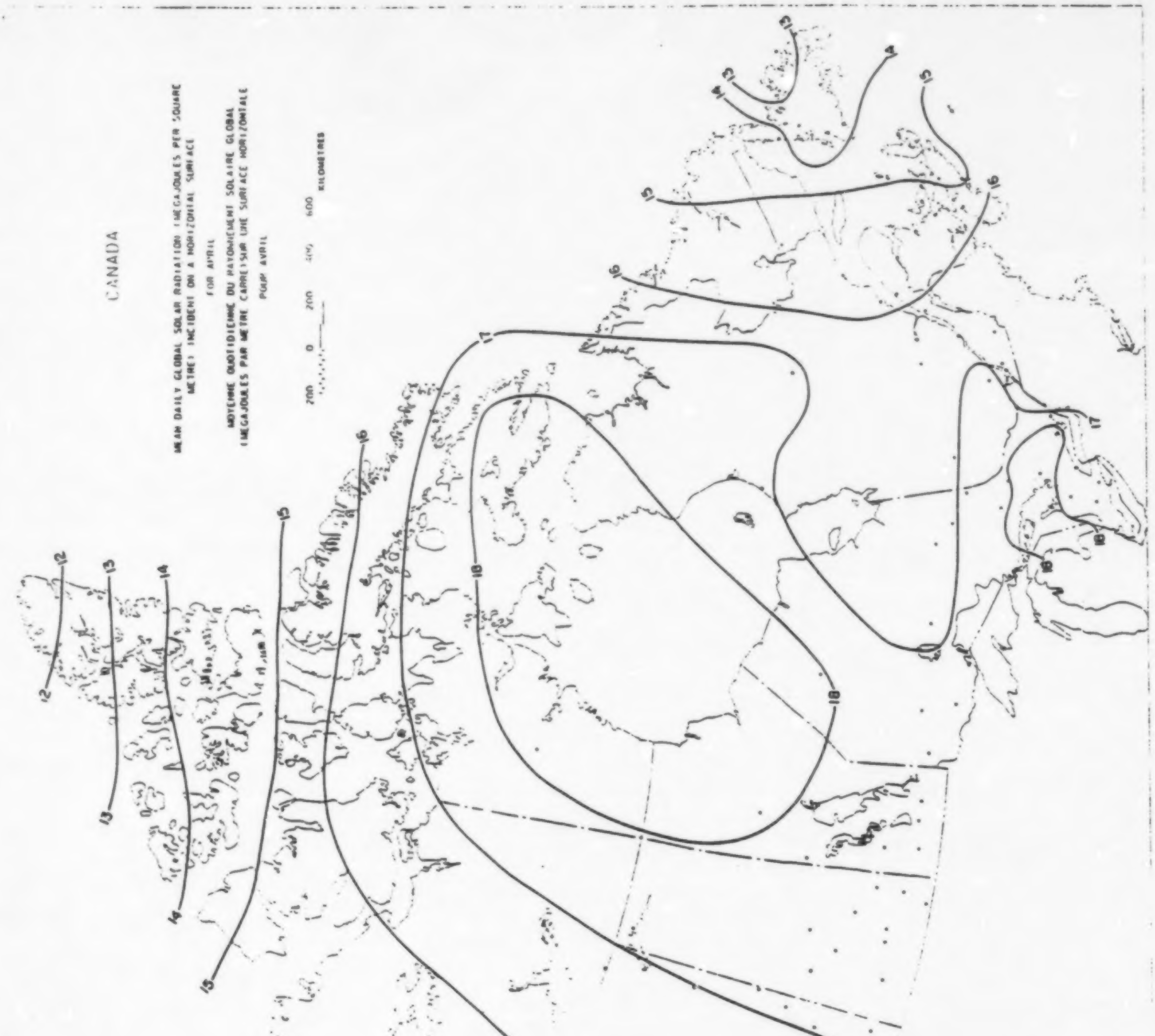

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR MARCH
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR MARS
KILOMETRES
2
3
4
5
6
7
8
9
10
11
12
13

FIG #: S58
MONTH: MARCH
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day



CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR APRIL
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR AVRIL
200 0 200 400 600 KILOMETRES
12
13
14
15
16
17
18

FIG #: S59
MONTH: APRIL
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

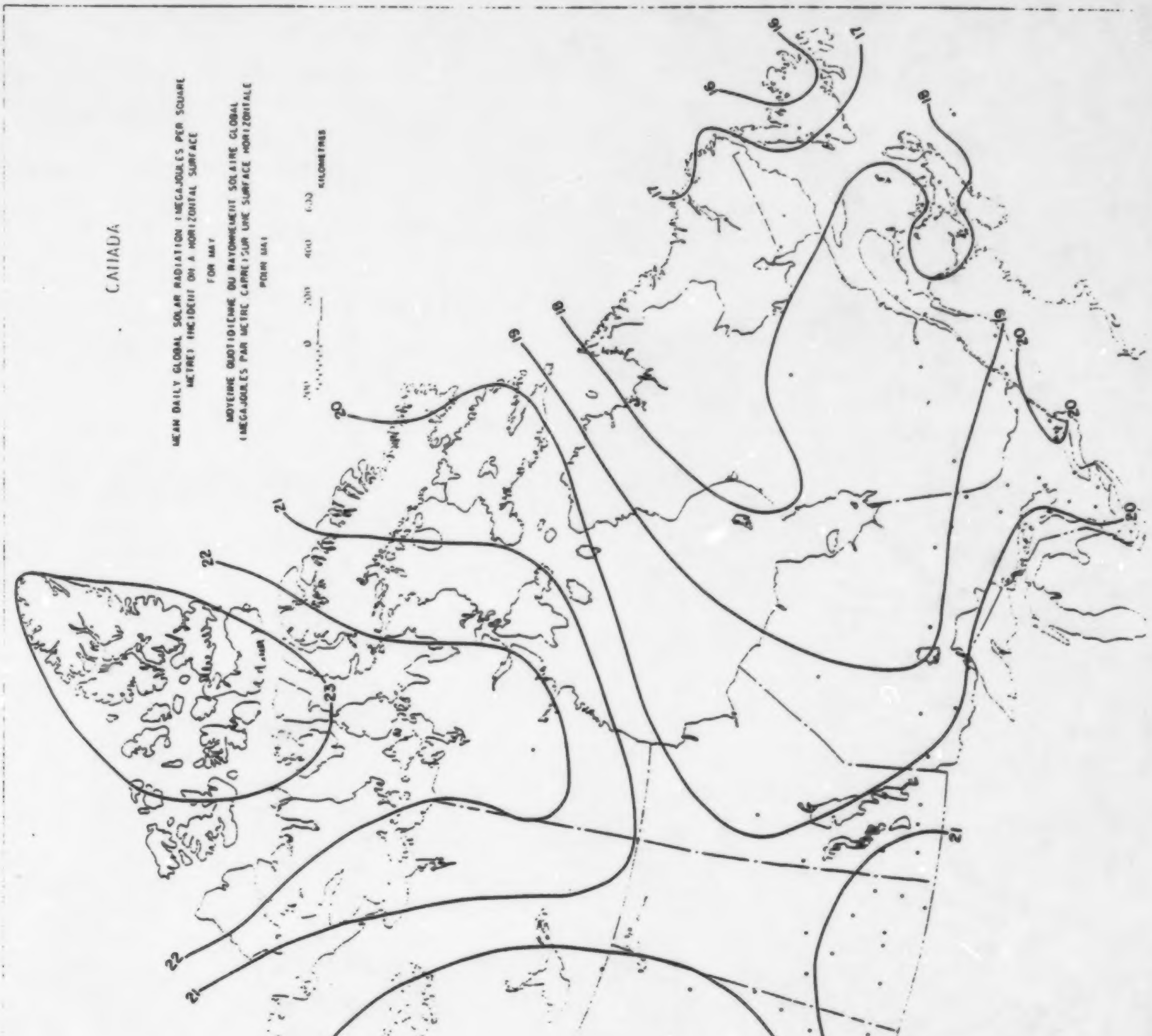

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR MAY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR MAI
200 0 200 400 600
KILOMETRES
16
17
18
19
20
21
22
23

FIG #: S60
MONTH: MAY
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

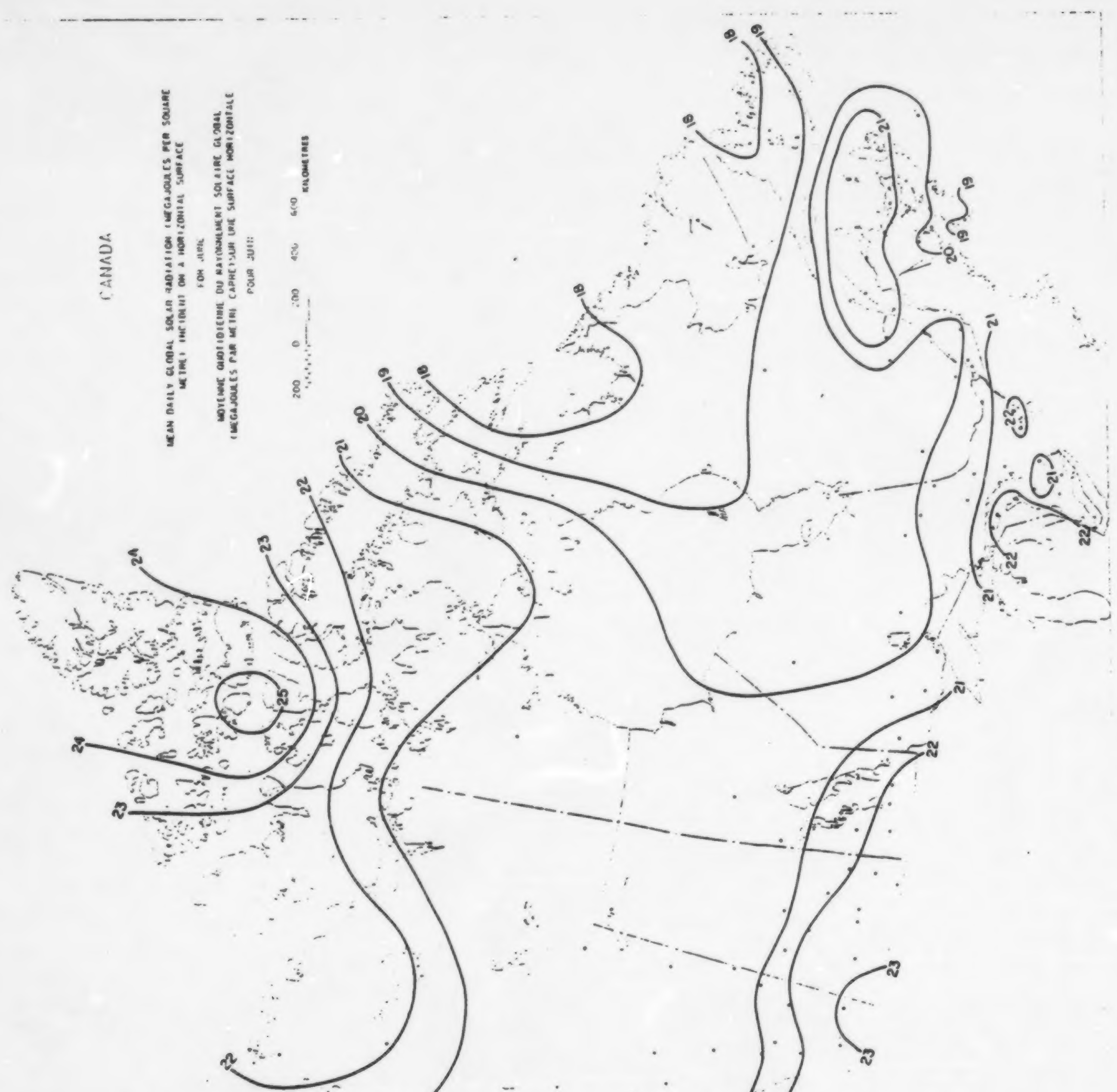

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR JUNE
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR JUIN
200 0 200 400 600
KILOMETRES
25
24
23
22
21
20
19
18
17
16

FIG #: S61
MONTH: JUNE
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

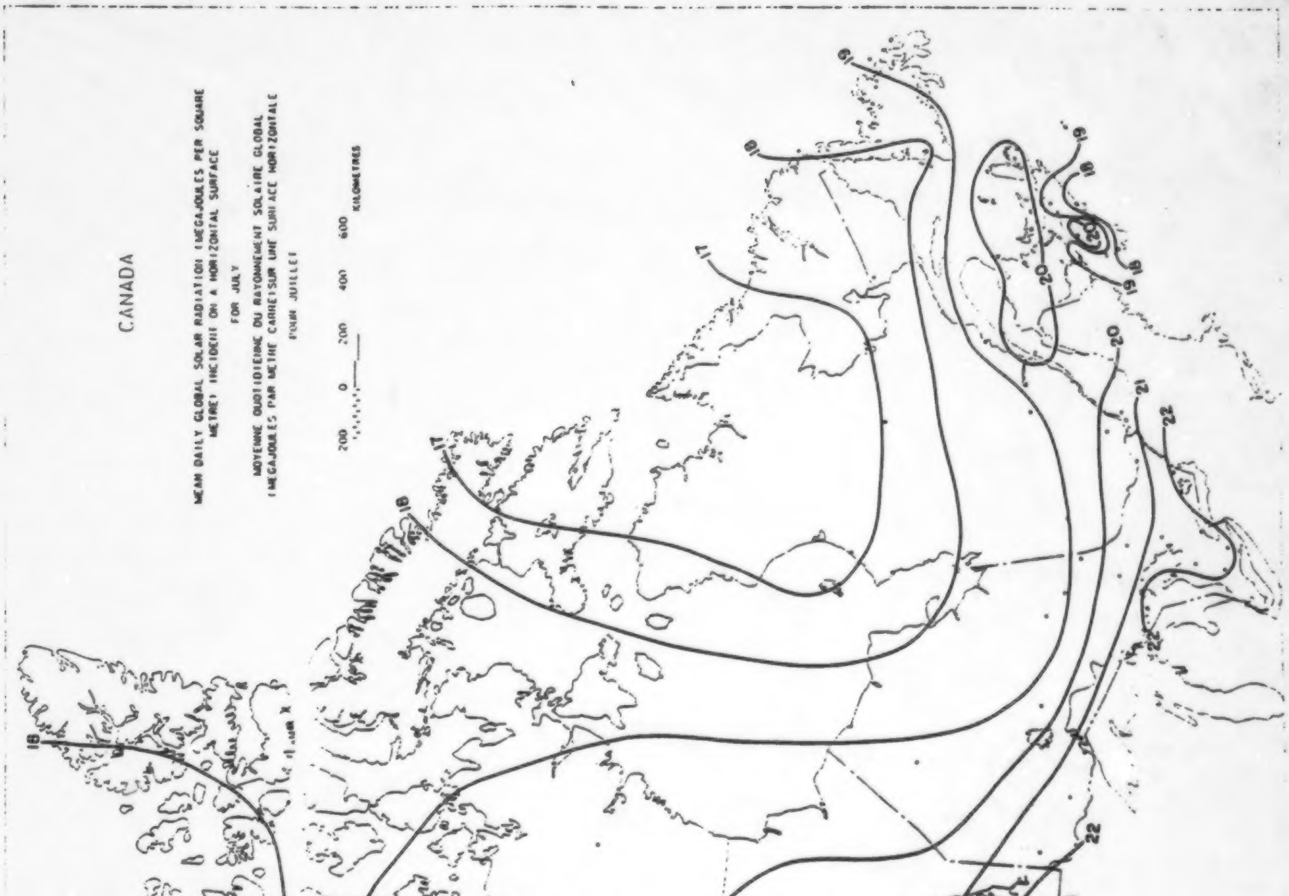

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR JULY
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR JUILLET
200 0 200 400 600 KILOMETRES
16
17
18
19
20
21
22
23
24
25

FIG #: S62
MONTH: JULY
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

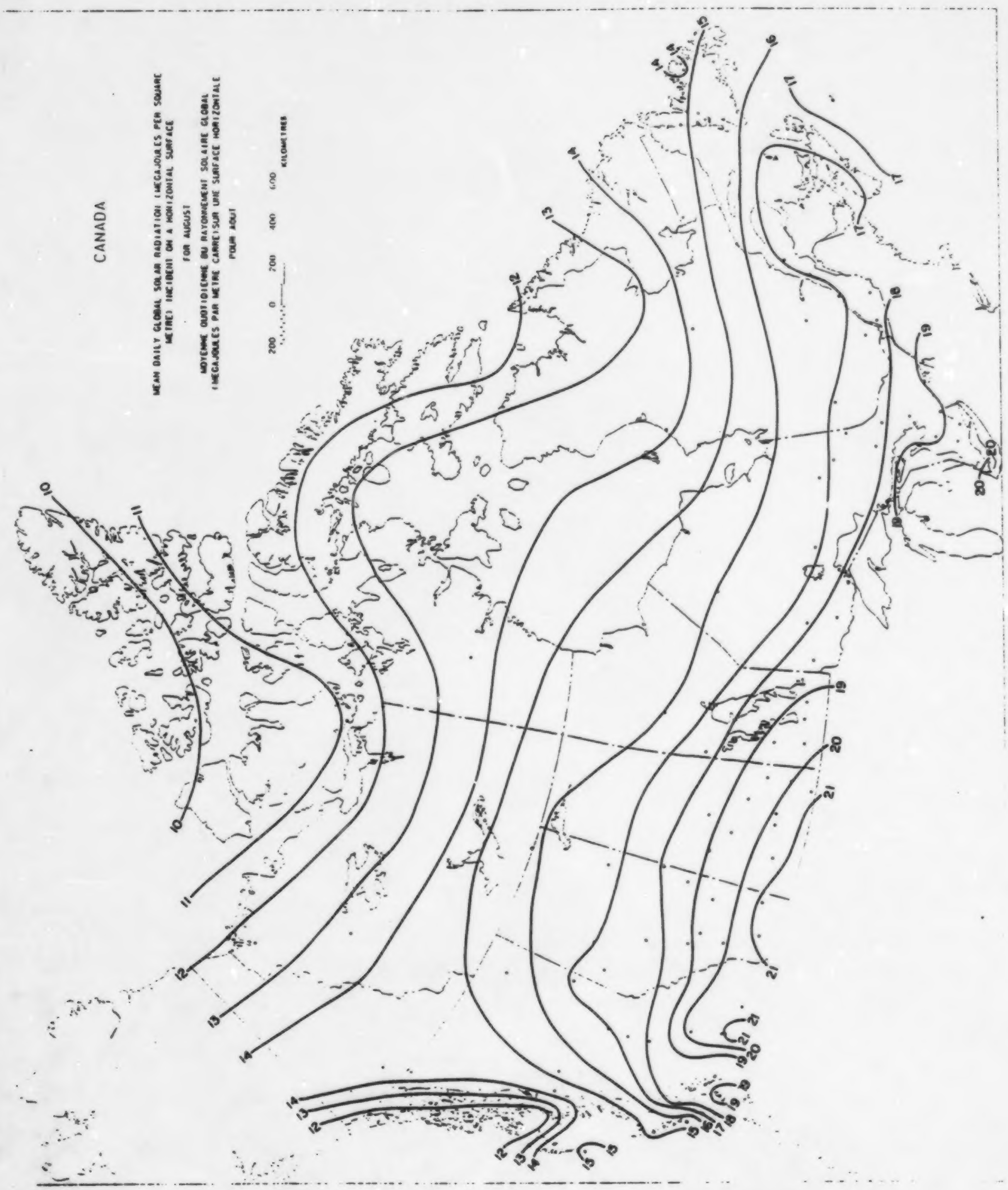

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR AUGUST
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR AOUT
200 0 200 400 600
KILOMETRES
10
11
12
13
14
15
16
17
18
19
20
21

FIG #: S63
MONTH: AUGUST
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

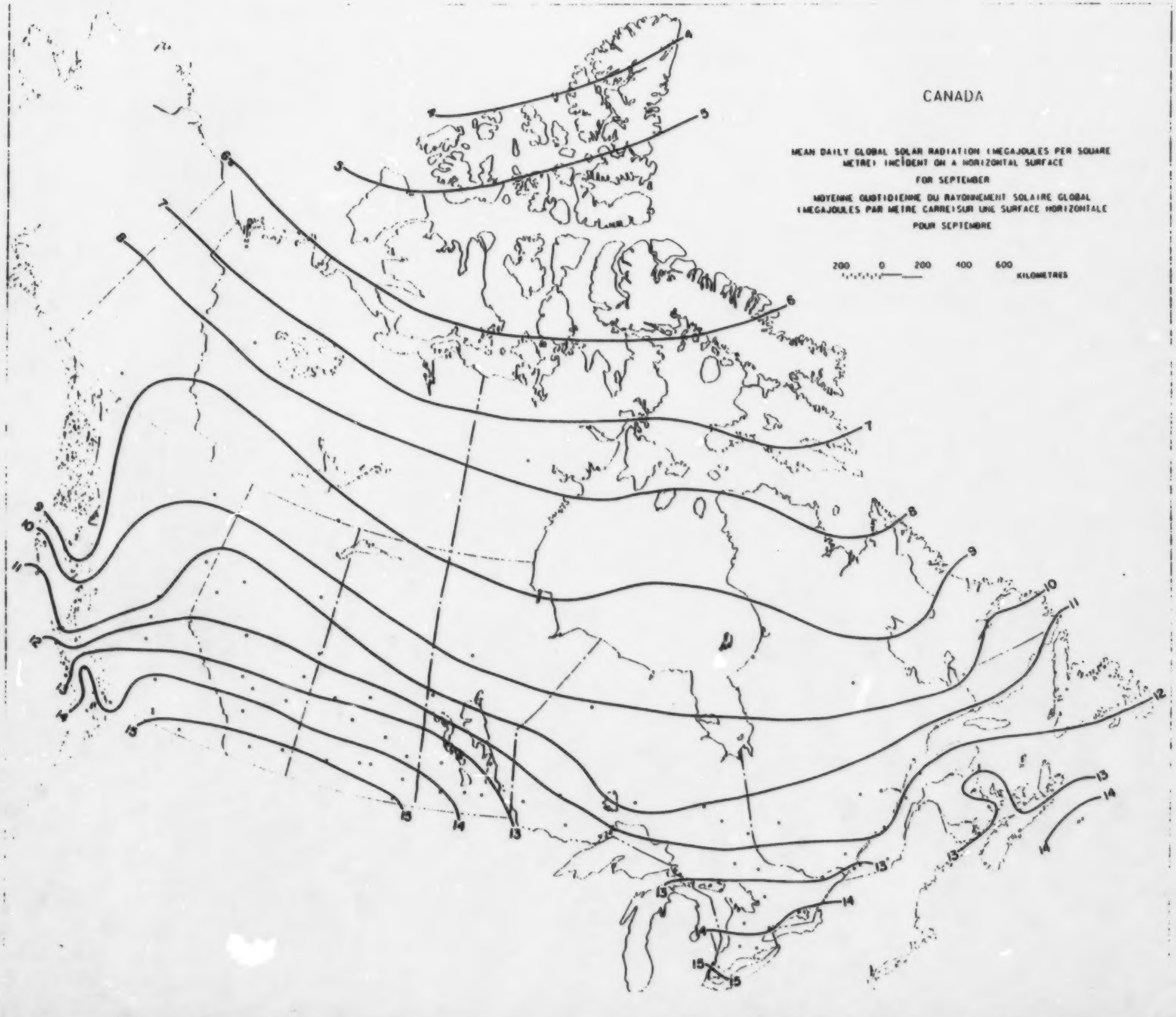

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR SEPTEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR SEPTEMBRE
200
0
200
400
600
KILOMETRES
4
5
6
7
8
9
10
11
12
13
14
15

FIG #: S64
MONTH: SEPTEMBER
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

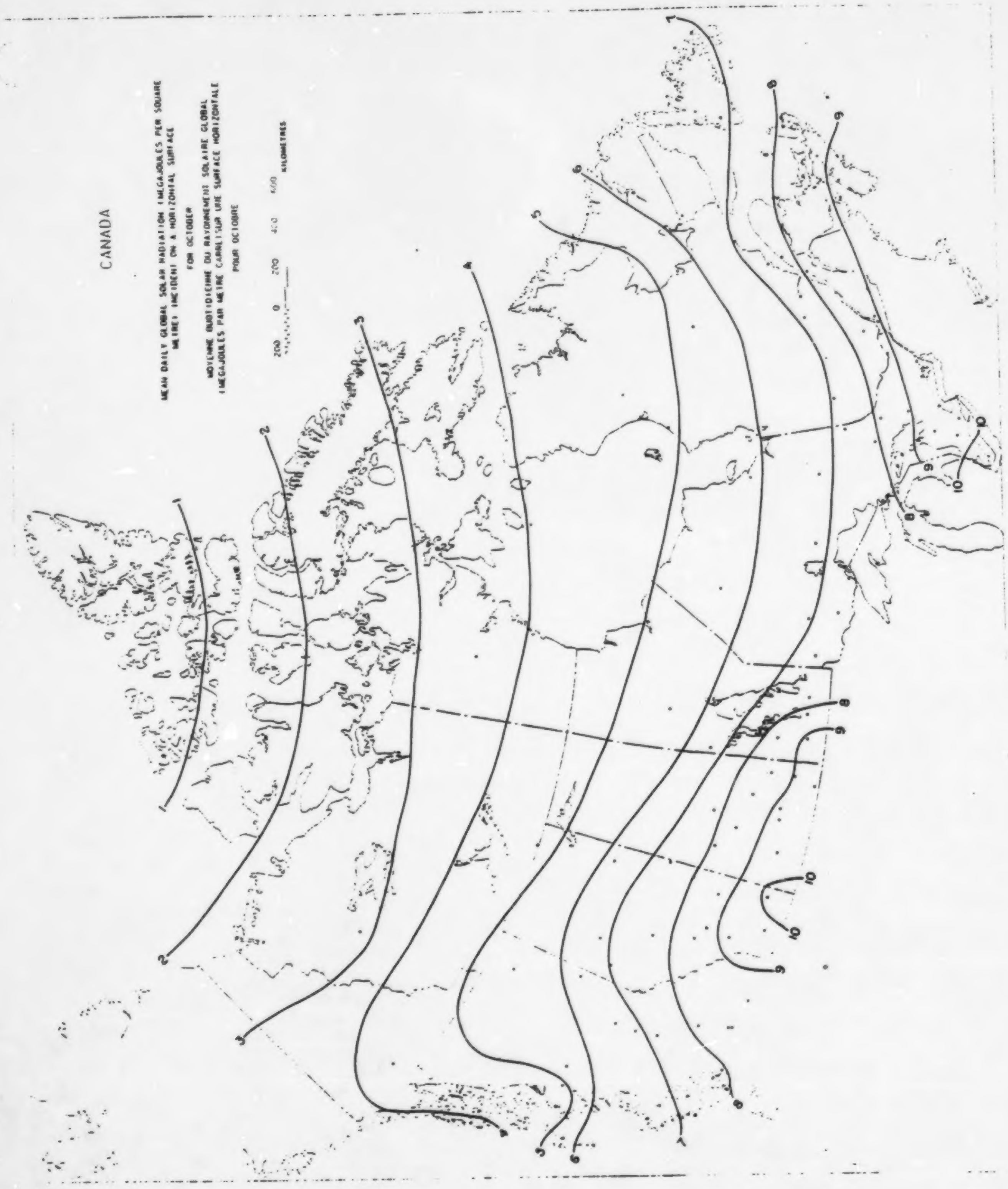

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR OCTOBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR OCTOBRE
200 0 200 400 600 KILOMETRES
1
2
3
4
5
6
7
8
9
10

FIG #: S65
MONTH: OCTOBER
ANGLE: 0°
UNITS: +3.6 for peak sun hours/day

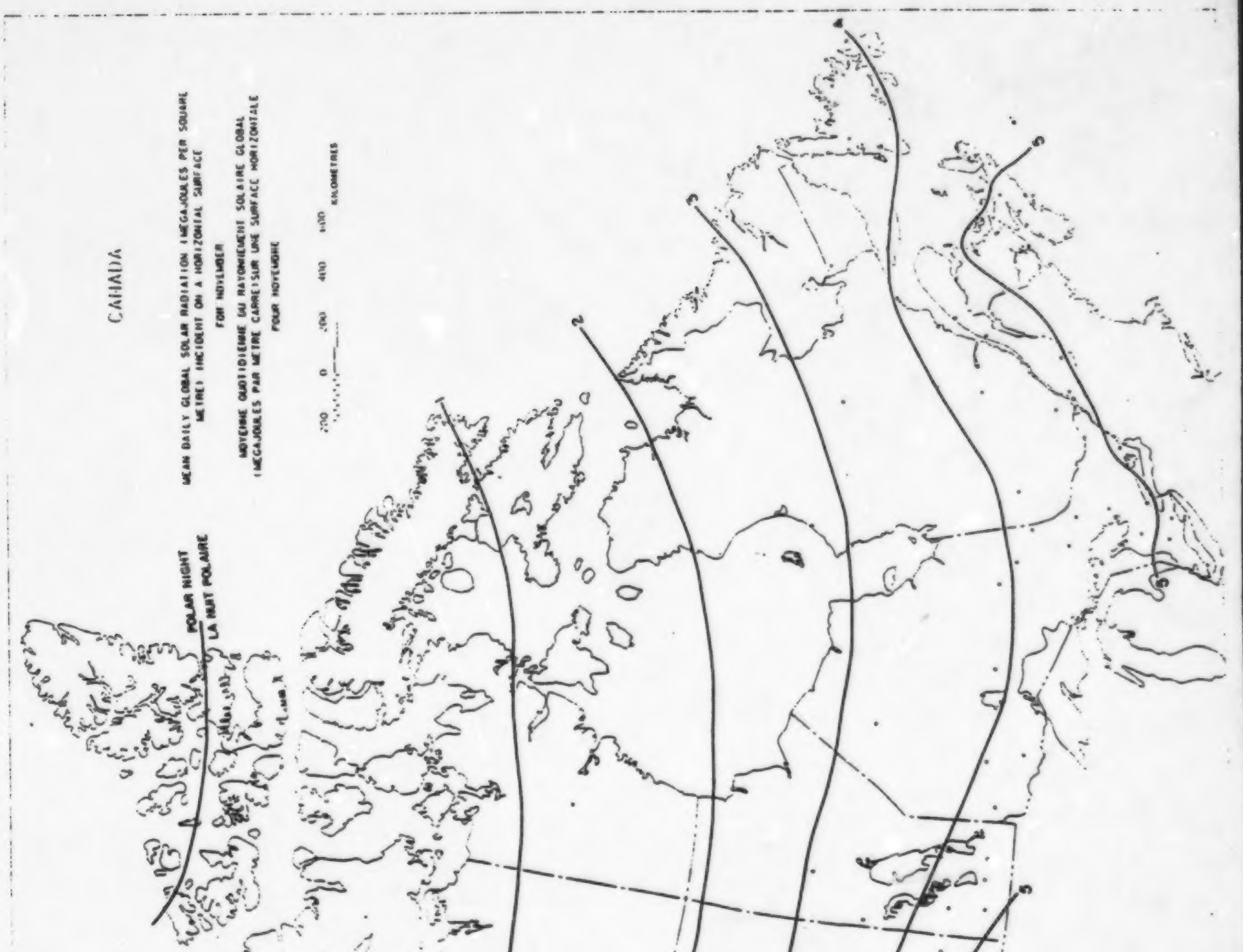

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR NOVEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR NOVEMBRE
200 0 200 400 600 KILOMETRES
POLAR NIGHT
LA NUIT POLAIRE
1
2
3
4
5
1
2
3
4
5
5
5

FIG #: S66
MONTH: NOVEMBER
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

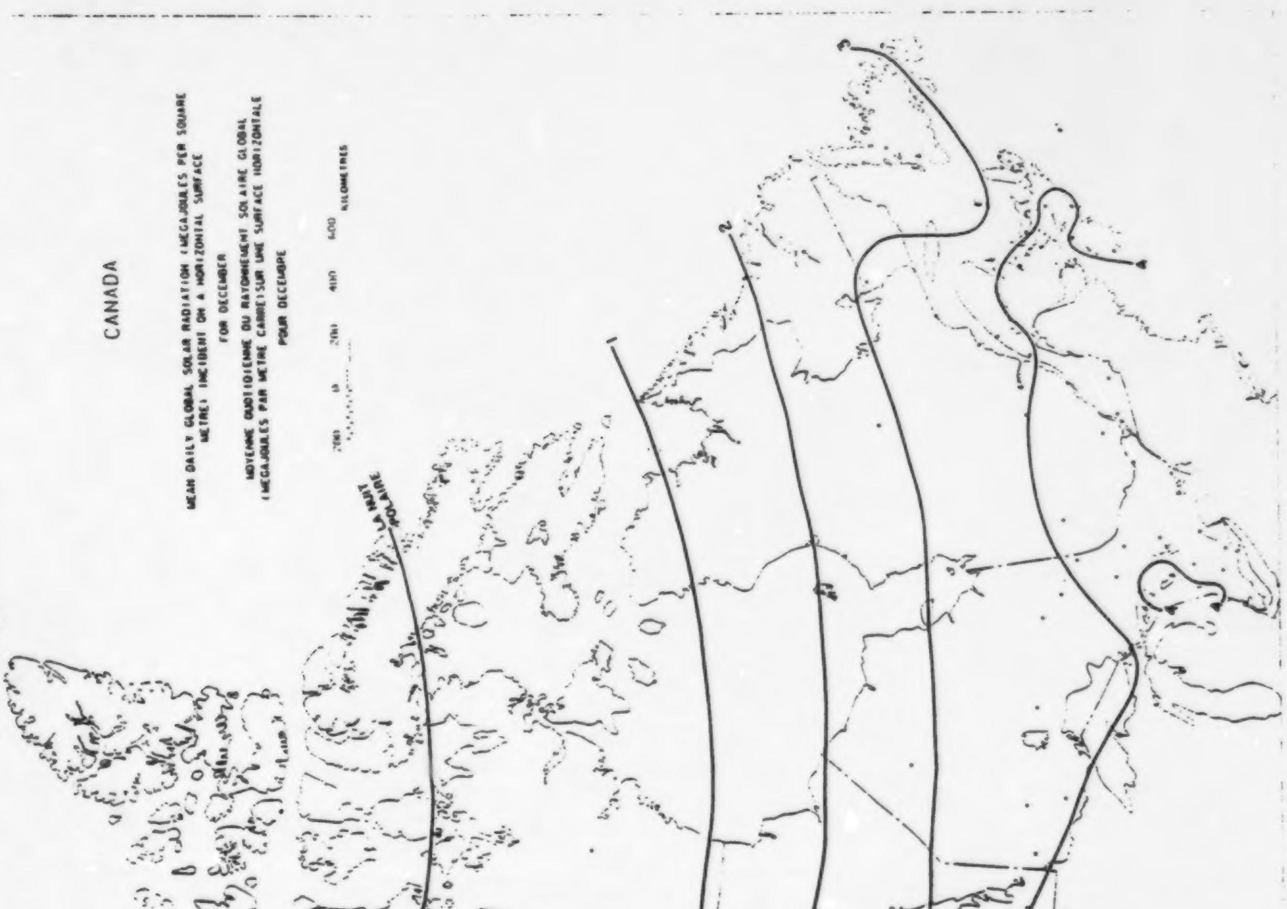

CANADA
MEAN DAILY GLOBAL SOLAR RADIATION (MEGAJOULES PER SQUARE METRE) INCIDENT ON A HORIZONTAL SURFACE
FOR DECEMBER
MOYENNE QUOTIDIENNE DU RAYONNEMENT SOLAIRE GLOBAL (MEGAJOULES PAR METRE CARRE) SUR UNE SURFACE HORIZONTALE
POUR DECEMBRE
200 0 200 400 600 KILOMETRES
LA NUIT POLAIRE
POLAR NIGHT
1
2
3
4

FIG #: S67
MONTH: DECEMBER
ANGLE: 0°
UNITS: ÷3.6 for peak sun hours/day

WORLD SUNLIGHT RESOURCE CONTOUR MAPS

Sunlight Availability vs. Season vs. Collector Tilt Angle

Map Data

- origin: "Water Pumping: The Soler Alternative" (NTIS publication)
- published by: Sandia National Labs DAC
- units: kWH/m^2/day (=peak sun hours/day)
- tilt angle is measured up from horizontal (0°)
- "seasons" are ascribed for the northern hemisphere
  (reverse seasonal descriptors when reading for the southern hemisphere)

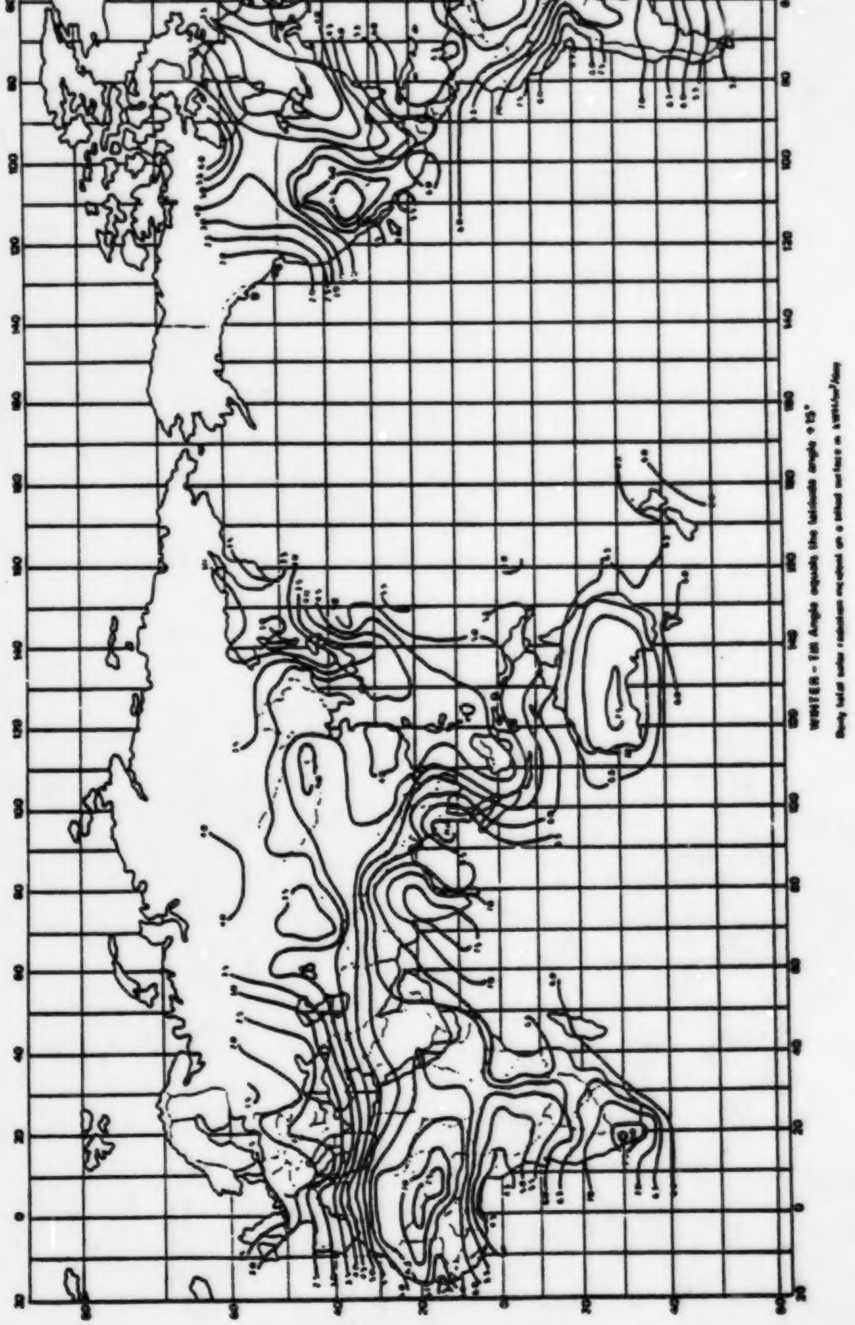

WINTER - Tilt Angle equals the latitude angle +15°
Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S69
SEASON: WINTER
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/day)

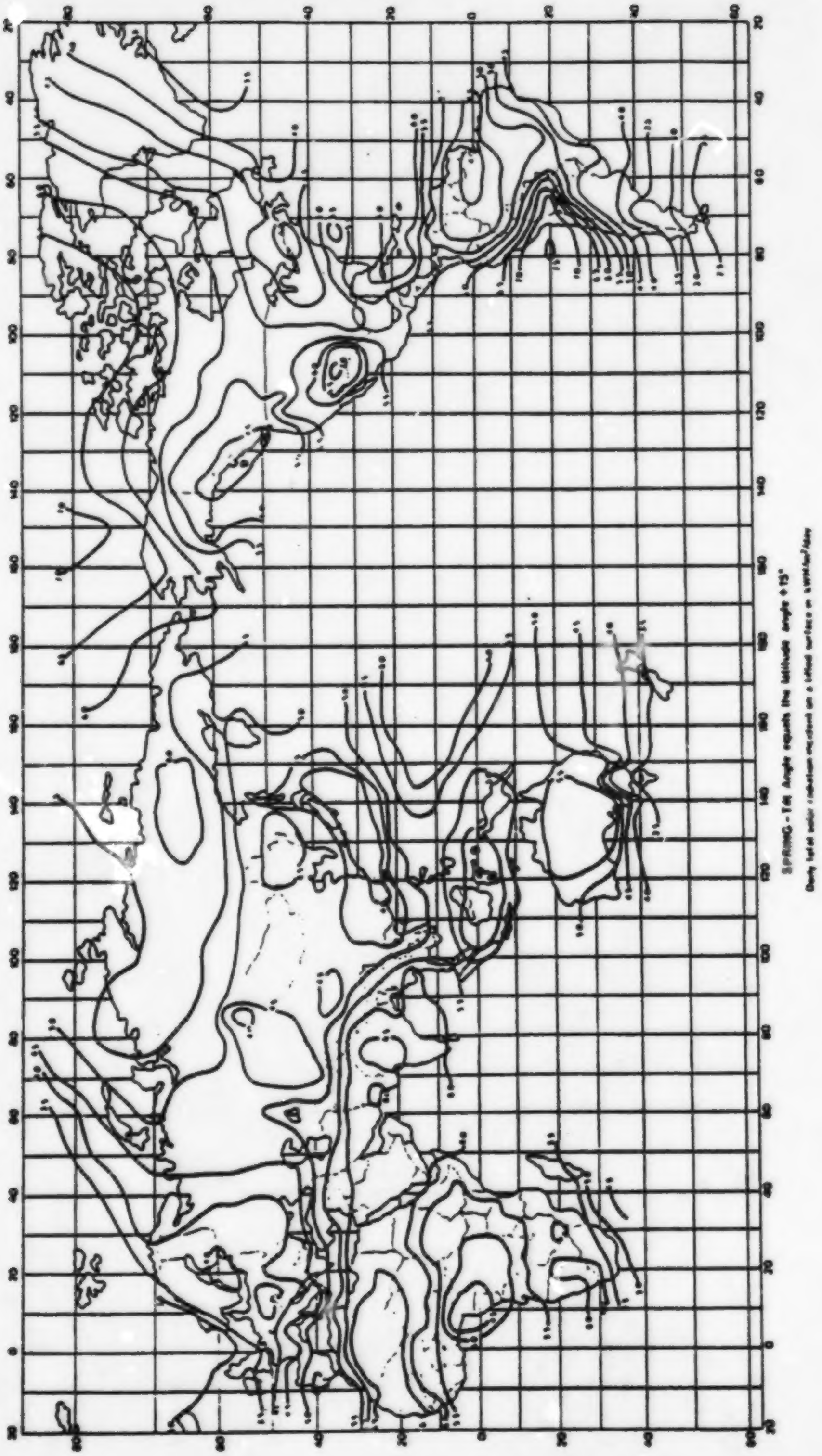

SPRING - Tilt Angle equals the latitude angle + 15°
Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S70
SEASON: SPRING
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/day)

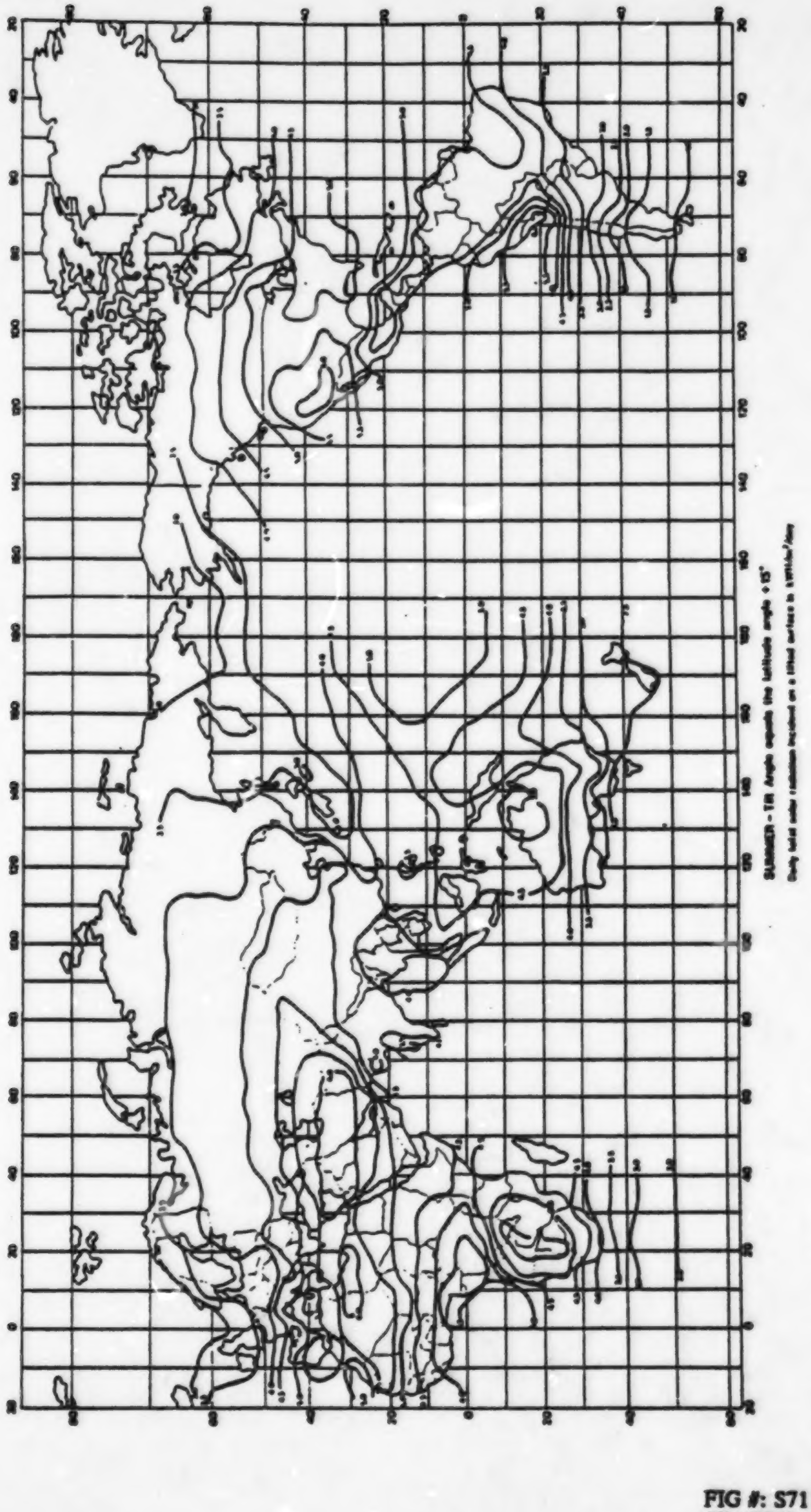
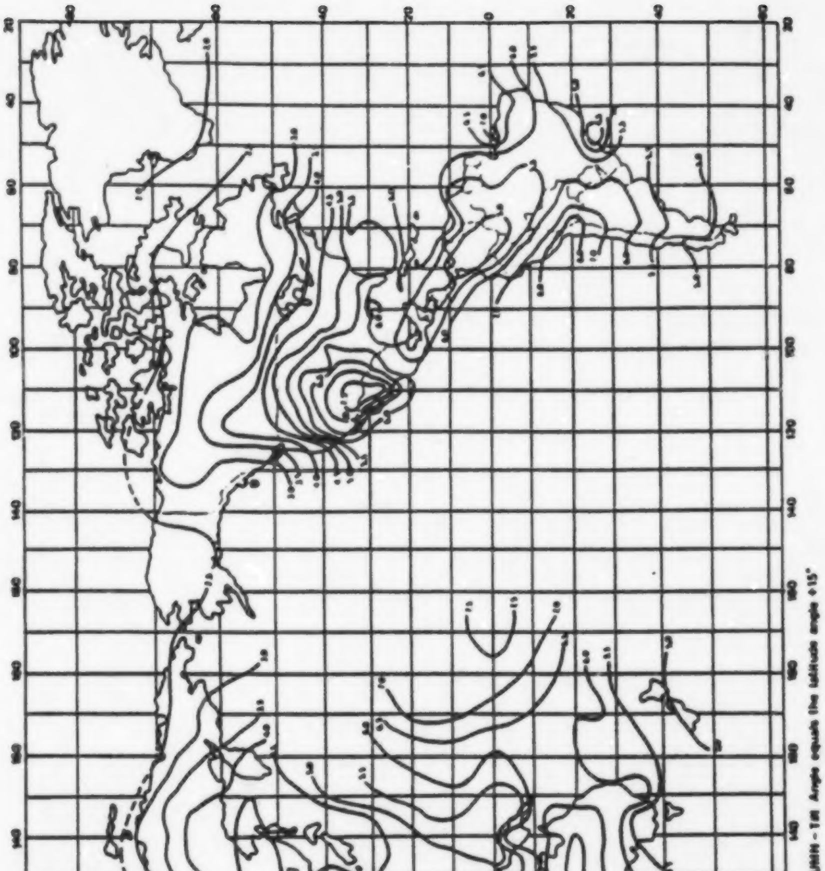

SUMMER - Tilt Angle equals the latitude angle +15°
Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S71
SEASON: SUMMER
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/day)



AUTUMN - Tilt Angle equals the latitude angle +15°

Daily total solar radiation incident on a tilted surface in kWh/m²/day

FIG #: S72
SEASON: FALL
ANGLE: LAT +15°
UNITS: kWH/m^2/day (= peak sun hours/da

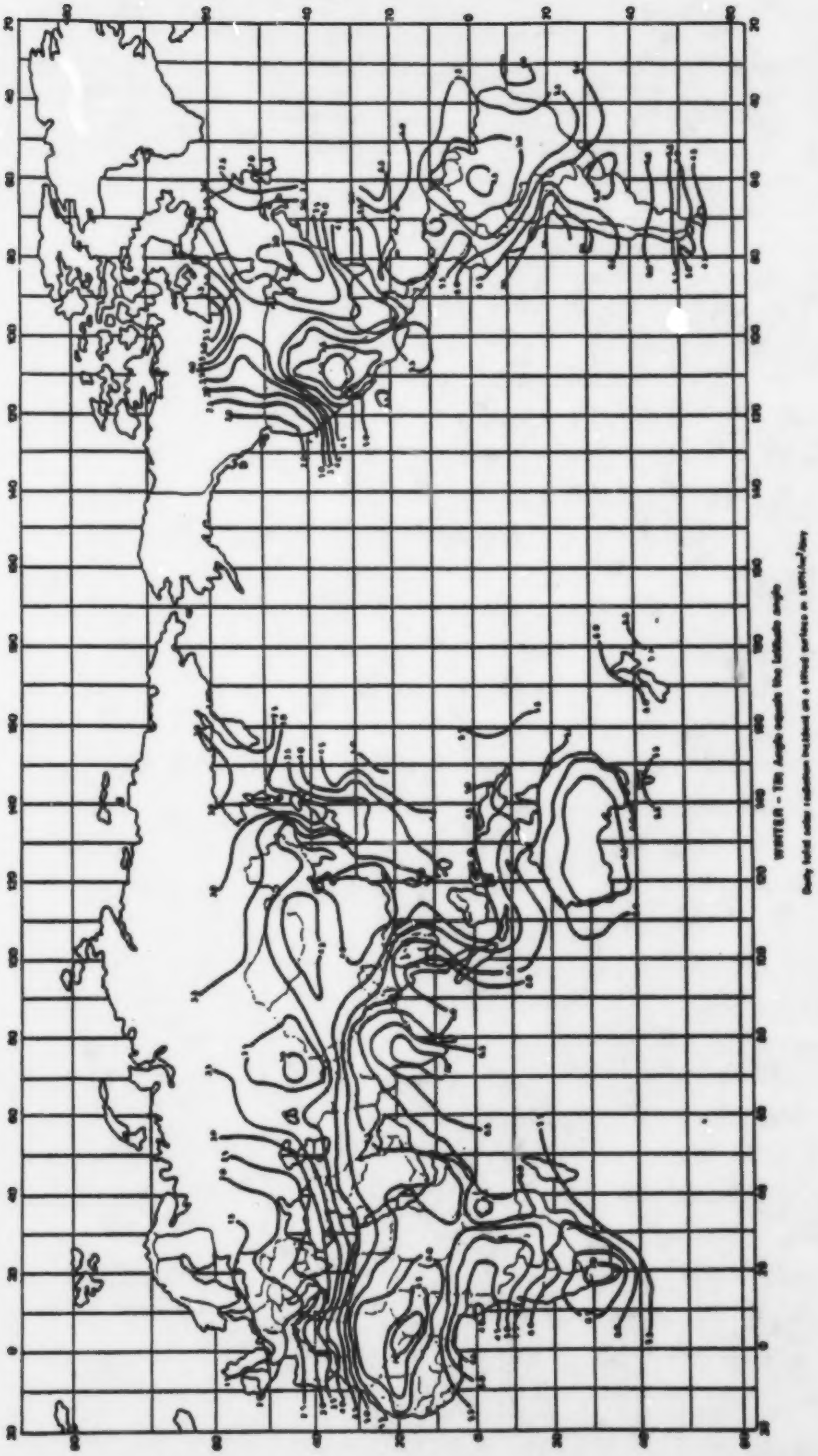
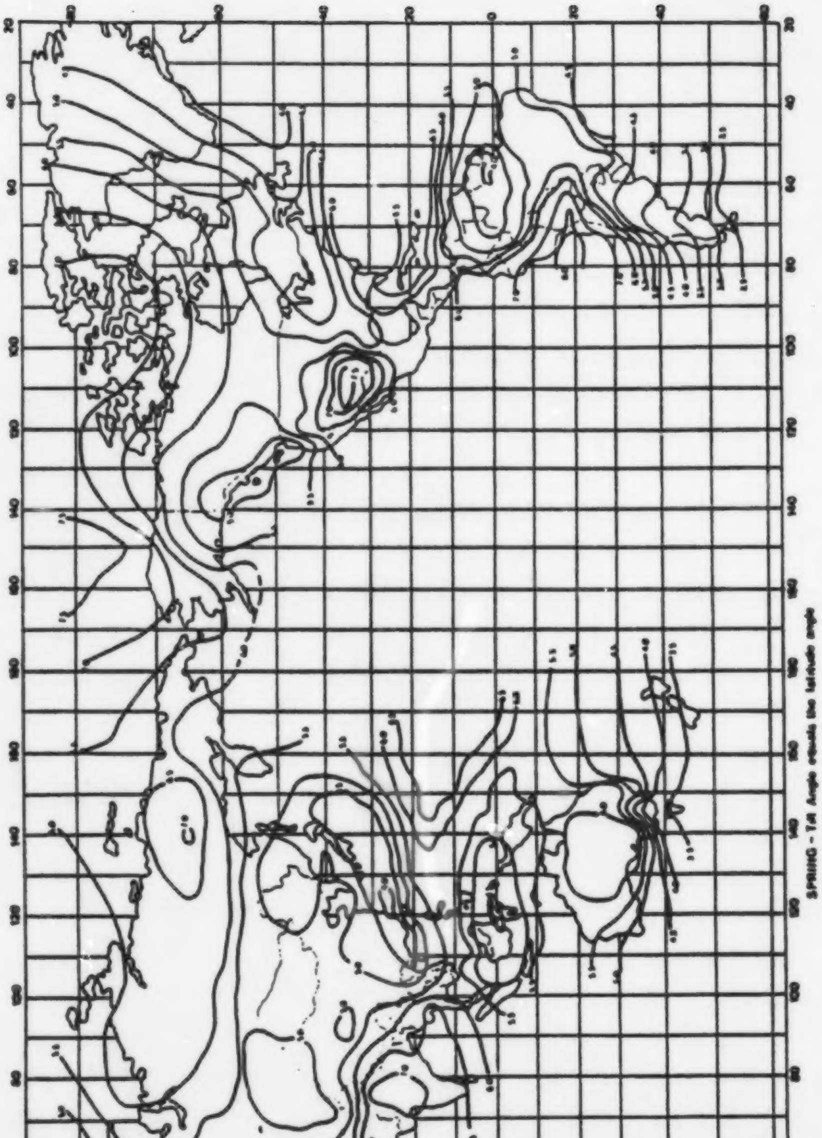


FIG #: S73
SEASON: WINTER
ANGLE: LAT
UNITS: kWH/m^2/day (= peak sun hours/day



SPRING - Tilt Angle equals the latitude angle

Daily total solar radiation received on a tilted surface in kWH/m²/day

FIG #: S74
SEASON: SPRING
ANGLE: LAT
UNITS: kWH/m²/day (= peak sun hours/day)

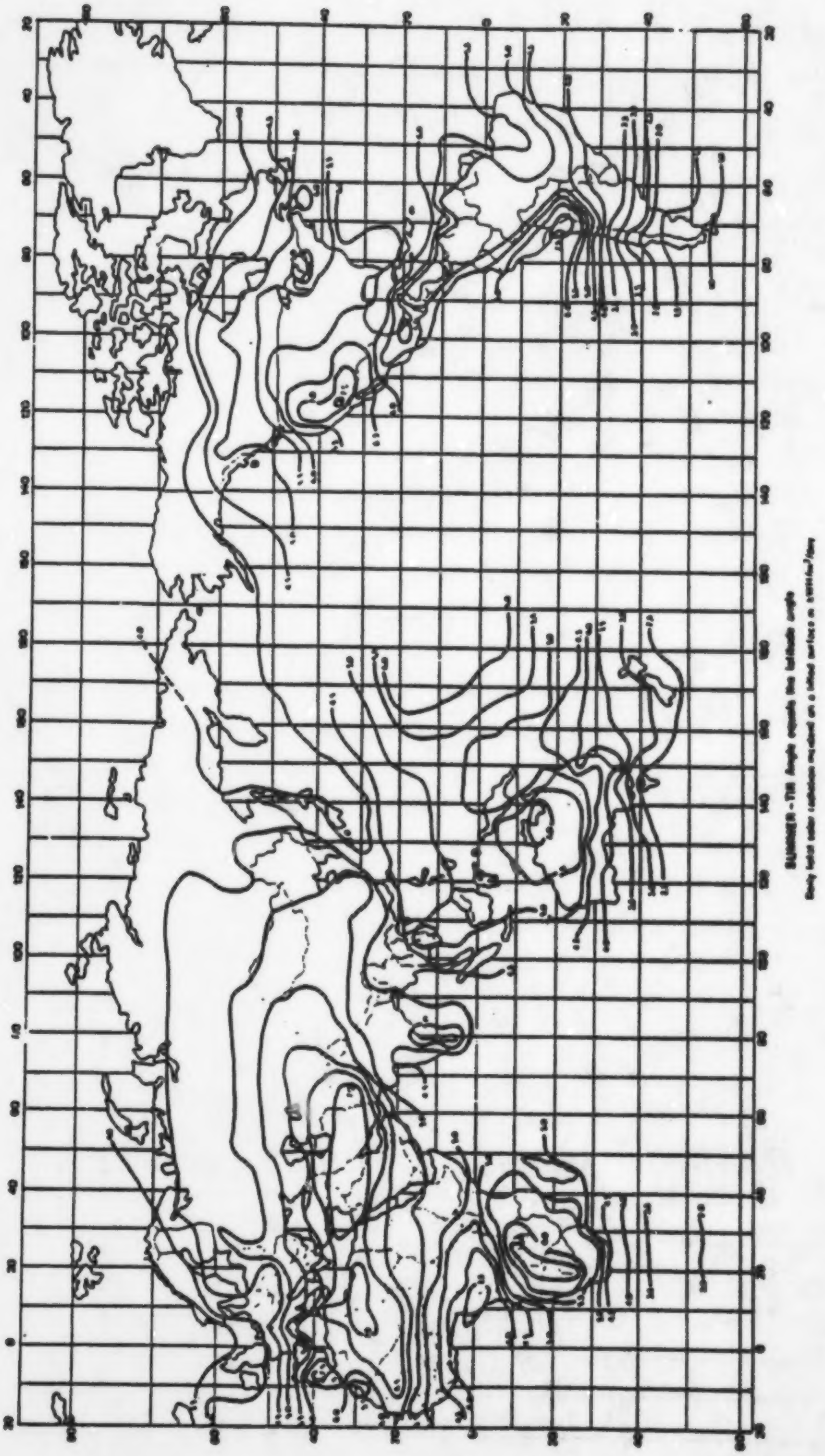


FIG #: S75
SEASON: SUMMER
ANGLE: LAT
UNITS: kWH/m^2/day (= peak sun hours/day)

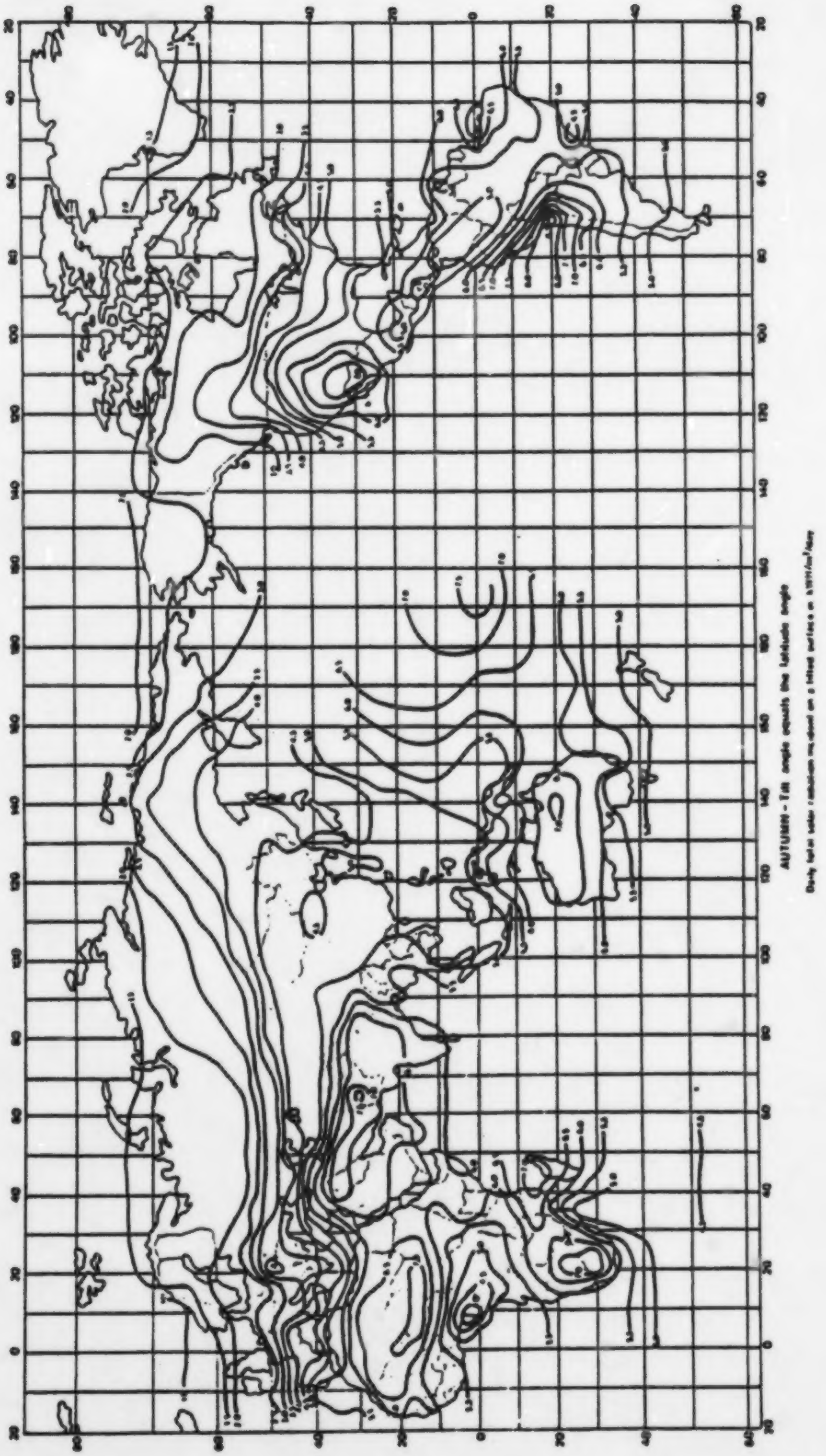

AUTUMN - Tilt angle equals the latitude angle
Daily total solar radiation received on a tilted surface in kWh/m²/day

FIG #: S76
SEASON: FALL
ANGLE: LAT
UNITS: kWH/m^2/day (= peak sun hours/d

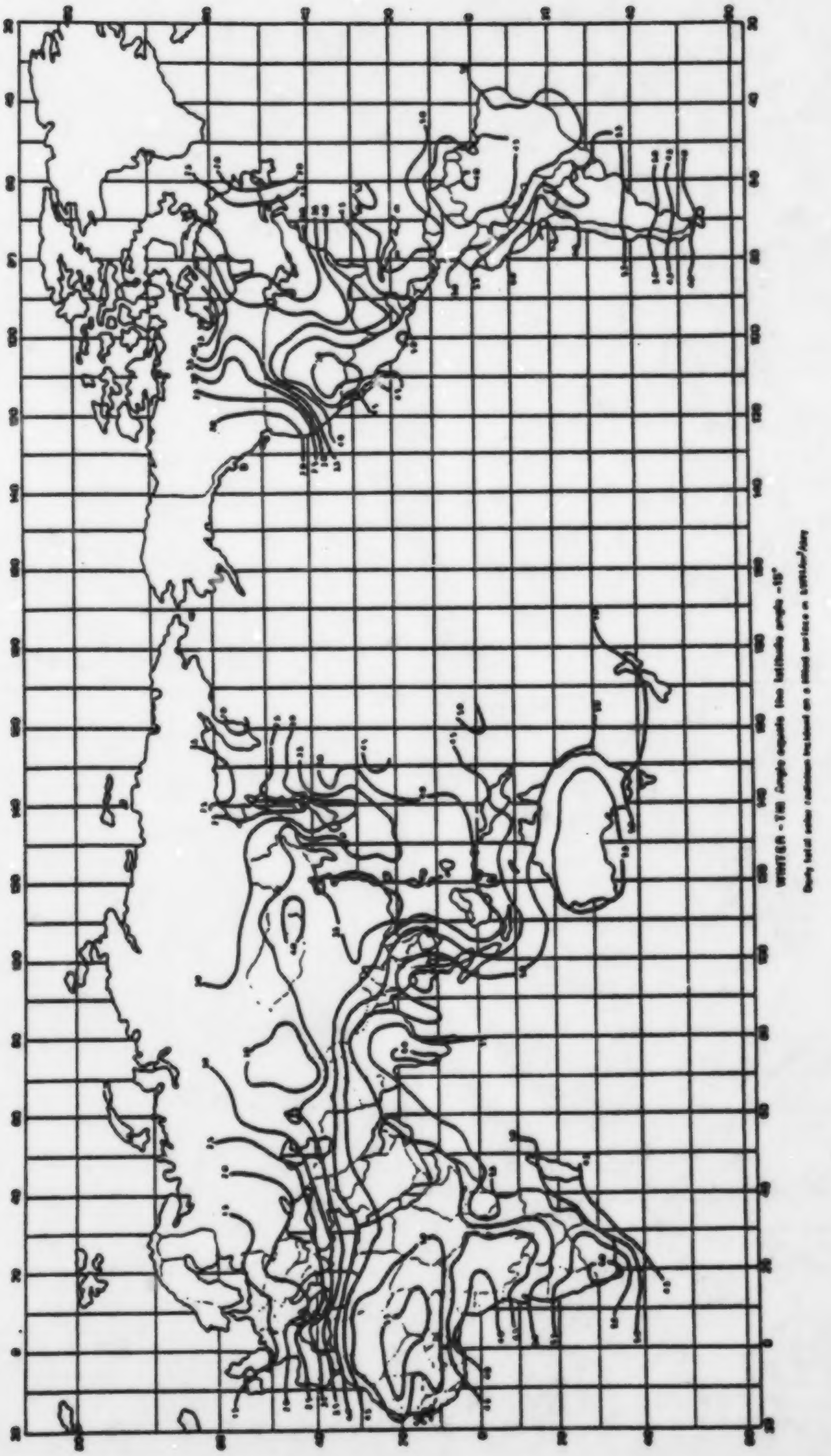
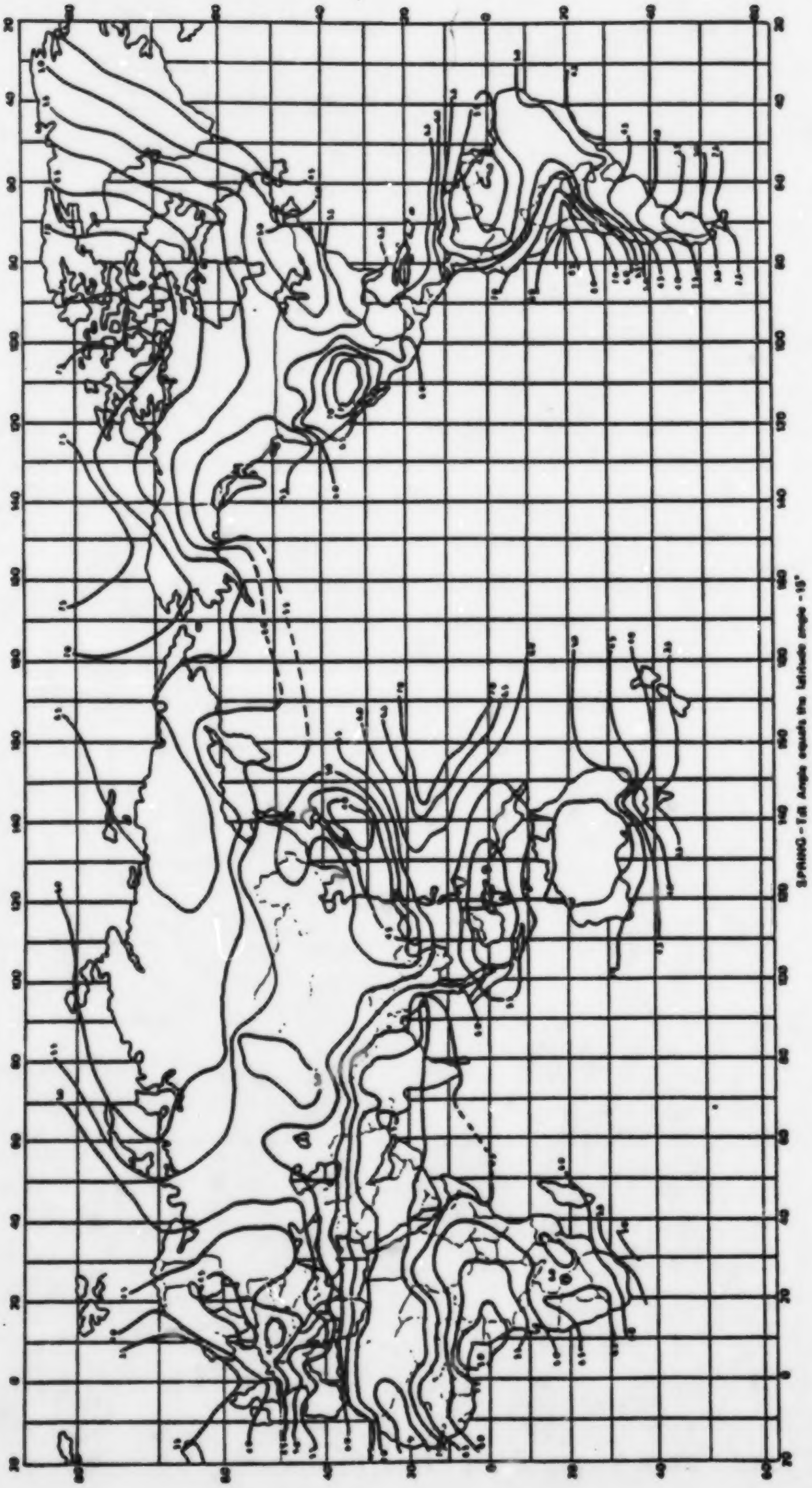

WINTER - Tilt Angle equals the latitude angle -15°
Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S77
SEASON: WINTER
ANGLE: LAT -15°
UNITS: kWH/m^2/day (= peak sun hours/day)



SPRING - Tilt Angle equals the latitude angle -15°

Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S78
SEASON: SPRING
ANGLE: LAT -15°
UNITS: kWH/m^2/day (= peak sun hours/da

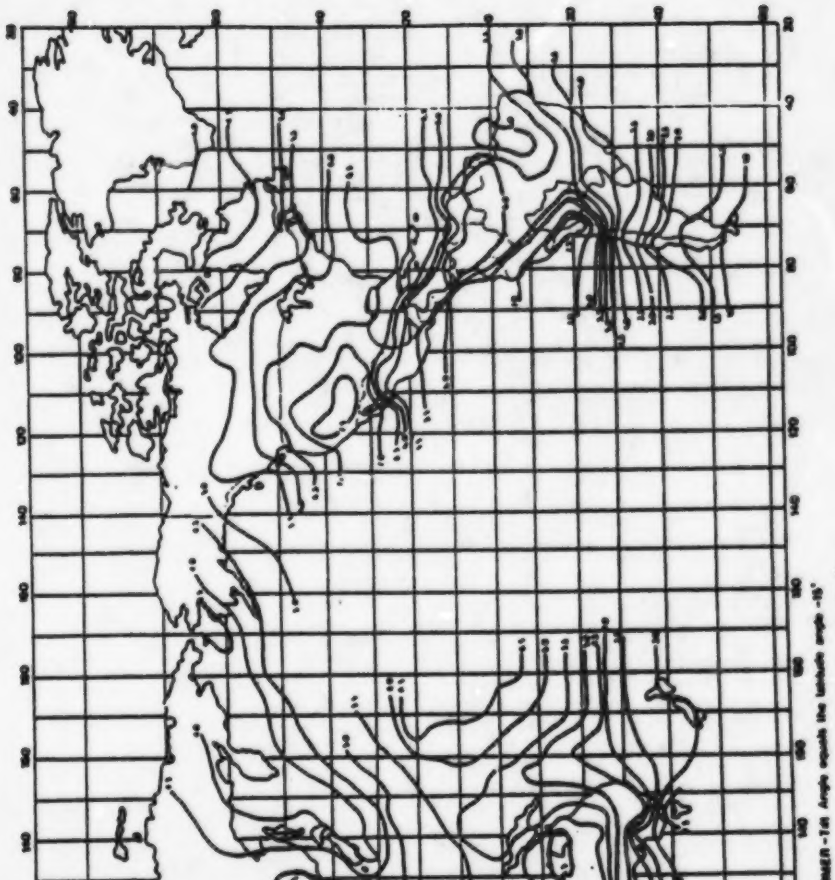
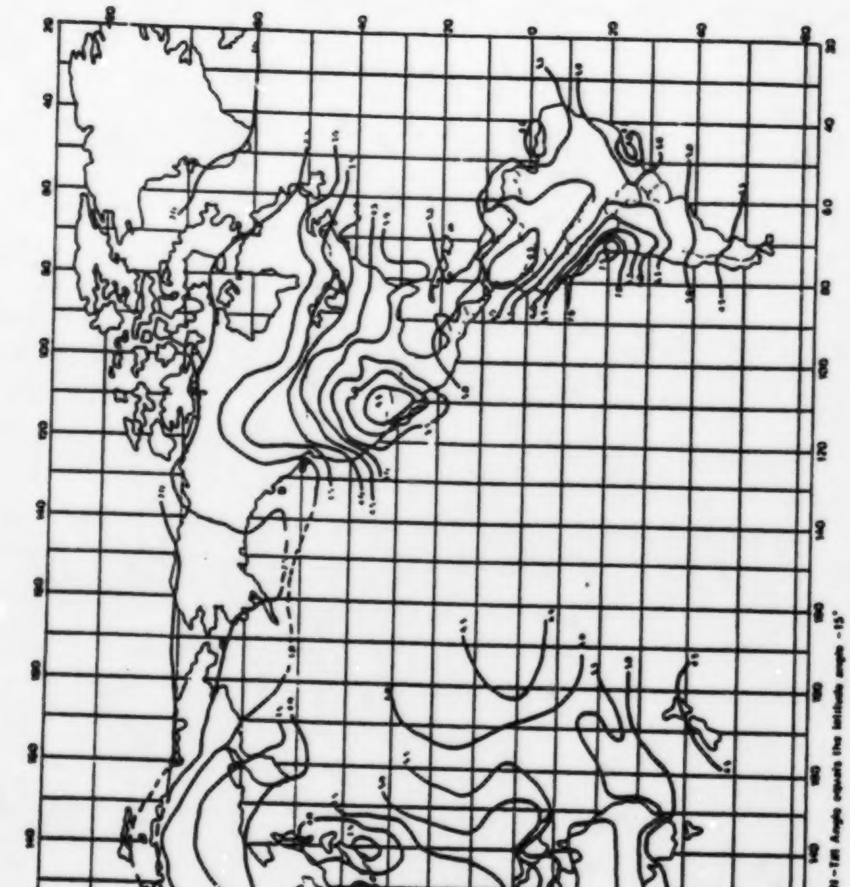

SUMMER - Tilt Angle equals the latitude angle -15°
Daily total solar radiation received on a tilted surface in kWh/m²/day

FIG #: S79
SEASON: SUMMER
ANGLE: LAT -15°
UNITS: kWH/m^2/day (= peak sun hours/day)



AUTUMN - Tilt Angle equals the latitude angle -15°

Daily total solar radiation incident on a tilted surface in kWH/m²/day

FIG #: S80
SEASON: FALL
ANGLE: LAT -15°
UNITS: kWH/m^2/day (= peak sun hours/da